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**Nutrition Knowledge, Attitudes, and Diet Associated With Postpartum Weight Retention in Low-Income and Minority Women**

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# Nutrition Knowledge, Attitudes, and Diet Associated With Postpartum Weight Retention in Low-Income and Minority Women

**by**

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**Nutrition Knowledge, Attitudes, and Diet Associated**

**With Postpartum Weight Retention in Low-Income and Minority Women**

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The purpose of this research was to discern associations of nutrition knowledge, attitudes, and diet with postpartum weight retention 1 year following childbirth. Subjects for this research were low-income, Hispanic, non-Hispanic black, and non-Hispanic white women recruited in a hospital 0 – 1 day postpartum. In study 1, a nutrition attitudes scale was developed and validated in 134 low-income women at 1.5 months post-delivery. The final scale was administered to a second group of 206 women at 1.5, 6 and 12 months postpartum. Attitudes at each time were compared to demographics and weight status. Obese women at 1 year had higher barriers to healthful eating subscale averages than normal and overweight subjects at 1.5 and 6 months, and overweight participants at 12 months. Obese individuals also had greater emotional eating subscale scores than both normal and overweight subjects at 12 months. In study 2, a test of general nutrition knowledge was developed and validated in a sample of 151 women at 1 day post-delivery. The validated instrument was then administered to a test sample of

140 women at 0 and 12 months postpartum. Body weights were measured at 1.5, 6, and 12 months and height 1.5 months. Women with < 5% weight retention at 1 year had greater knowledge at 0 (53% vs.49%, $p<0.05$) and 12 months (55% vs. 51%, $p <0.05$) than those with ≥ 5%. Women who lactated ≥ 6 months had more knowledge than those who lactated < 6 months. In study 3, 182 women visited the research site at 1.5, 3, 6, and 12 months postpartum where dietary data were collected via one 24-hour recall and 2 days of diet records. Weight status was measured during each clinic visit; height was measured at 1.5 months. At 1 year postpartum, obese women had a greater percentage of energy from carbohydrates than their normal weight counterparts (52.5 % vs. 49.6%, $p<0.05$). Less than half of the population met the recommendations for folate, calcium, magnesium, and vitamins B6, D, E and C at all time points, regardless of ethnicity, BMI and lactation status.

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# Chapter 1: Review of Literature

The current rates of overweight and obesity in the United States (U.S.) are of epic proportions. According to recent studies, the majority of adults (age $\geq$ 20 years) in the U.S. are considered to be overweight (66.3%) (body mass index [BMI, kg/m$^2$] = 25 – 30) or obese (32.2%) (BMI $\geq$30) (Ogden et al. 2006). This incidence is of a great concern as it is widely accepted that an unhealthy weight status is associated with other serious health problems, such as hypertension, diabetes, cardiovascular disease (CVD), and arthritis (Visscher et al. 2004, Wilson et al. 2002, Brown et al. 2000). In monetary terms, annual health care expenditures attributable to the treatment of overweight and obesity have been estimated to cost $3,338 per capita (Wee et al. 2005), or as much as $78.5 billion. The human cost is far more serious, as an unhealthy weight status reduces lifespan (Finkelstein et al. 2003), and has been estimated to prematurely claim 111, 909 lives in the U.S. in 2000 (Flegal et al. 2005).

Current data indicate that obesity afflicts women more than men (33.2% vs. 31.1%, respectively) (Ogden et al. 2006). Those who are particularly at risk are those of low socio-economic status, Hispanic and non-Hispanic Black ethnicity (Hedley et al. 2004, Mokdad et al. 2003, Kristal et al. 1999), and childbearing age (Hedley et al. 2004, Rooney et al. 2002, Healthy People 2010). Furthermore, long-term studies have demonstrated that weight retained from a pregnancy has been implicated in the development of an unhealthful weight status in the years following childbirth (Rooney et al. 2005, Linne et al. 2004, Kac et al. 2004, Rooney et al. 2002, Lederman et al. 2002). To illustrate, a recent study of Brazilian women (n = 405) found that more than a third of every kilogram gained during pregnancy was retained at 9 months postpartum (Kac et al. 2004). In a much larger sample of Swedish women (n = 2,342), Linne et al. (2004) reported that pregnancy-related weight gain remained for as long as up to 15 years postpartum. Within the U.S. Rooney et al. (2002) studied the effects of a failure to lose weight gained from pregnancy by 6 months postpartum and weight status 8 – 10 years later in a sample of predominantly non-Hispanic white, middle-class women (n = 795). Results showed that those who failed to lose pregnancy-related weight at 6 months were, on average, 10.7 kilograms heavier than their prepregnancy weight. In a follow-up study, the same group of researchers reported that the excessive weight gain persisted at 15 years postpartum, and was also linked to an increased risk for diabetes, heart disease, and hypertension (Rooney et al. 2005).

A plethora of variables influence postpartum weight retention. Past research has implicated factors such as excessive gestational weight gain (Linne et al. 2004, Olson et al. 2004, Walker et al. 2004), lactation status (Kac et al. 2004, Adair et al. 2004, Kugyelka et al. 2004), maternal insulin concentrations (Scholl et al. 2002), and age (Valeggia et al. 2003). Others have found that psychosocial influences, such as depressive symptoms (George et al. 2005a, Gracious et al. 2005, Walker et al. 2004), body image (George et al. 2005a, Walker et al. 2004), and weight-related distress (George et al. 2005a, Walker et al. 2004) may influence weight status after childbirth. However, there is surprisingly little information regarding the impact of the psychosocial influences of nutrition knowledge and attitudes towards nutrition on postpartum weight status.

Many studies have measured nutrient intake in within the first year postpartum. These include studies of women in the U.S. (George et al. 2005a, George et al. 2005b, Olson et al. 2005, Walker et al. 2004, Berg et al. 2001, Mackey et al. 1998, Heck and de Castro 1993, Finley et al. 1985, Song et al. 1985, Butte et al. 1981), Australia (Zhou et al. 2005), Canada (Morin et al. 1999, Doran and Evers 1997), China (Yang et al. 2000), India (Agrahar-Murugkar and Pal 2004), Iran (Ayatollahi 2004), Italy (Giammarioli et al. 2002), New Zealand (Todd and Parnell 1994), Spain (Carbone et al. 1992), Tokyo (Chan et al. 2001), and the United Kingdom (UK) (Black et al. 1986). Of these, none of these above mentioned research directly compared nutrient intake to postpartum weight status except that of Morin et al. (1999). In 1999, Morin et al. (1999) compared the diets of 67 non-Hispanic black (n = 40) and non-Hispanic white women (n = 27) at 24 hours, 1, 2, and 4 months postpartum. In summary, Morin and colleagues found that overweight and obese women consumed more protein and fat than underweight and normal weight subjects.

Clearly, there is a lack of research related to nutrition attitudes, knowledge, and dietary behavior in postpartum populations. A better understanding of these concepts could be useful to those who seek to design successful postpartum weight retention interventions. Therefore, the overall goal of the present research is to study and determine the influence of these factors with regards to postpartum weight retention in low-income, minority women. For the purpose of this research, postpartum will be defined as 0 – 12 months following childbirth.

## NUTRITION ATTITUDES AND MOTIVATIORS FOR EATING

The first aim of this research is to explore the influence of nutrition attitudes and motivators for eating on postpartum weight retention in low-income mothers during the first year postpartum. To accomplish this goal, a reliable and valid instrument that measures these constructs within the target population will be developed. In this research, a nutrition attitude is defined as a feeling of favorableness or unfavorableness towards nutrition-related concepts.

To date, there are many studies which have assessed nutrition attitudes in adults of low to high SES, the majority of which are not during postpartum. A review of this body of research reveals a common attitudinal theme referred to as 'barriers' to healthy eating. A summary of these studies is listed in (Table 1.1). These barriers represent any internal or external influence which is perceived as an obstacle to adopting a healthier diet. One of the most frequently reported barriers to healthy eating reported associated with low-income U.S. populations cost (Palmeri et al. 1998, Dibsdall et al. 2003, Kieffer et al. 2004, Eikenberry et al. 2004, Chatterjee et al. 2005). According to this research, low-income individuals feel they simply can not afford to buy healthier, and typically more expensive, foods. Alternatively, low-income individuals may also perceive healthful foods as unaffordable, independent of actual cost. This perception of high costs is enough of a deterrent to procure healthful food items.

**Table 1.1. Barriers to healthy eating.**

| Study | Sample | Instrument/ Measurement | Barriers |
|---|---|---|---|
| Lappalaine et al. (1997) | N = 14, 331 adults (EU)<br><br>Men = 6702, Women = 7614<br><br>SES* = unreported | In-person interview. Subjects asked to rank a list of 22 possible barriers to healthy eating | Time<br>Self-control<br>Resistance to change<br>Food preparation<br>Cost<br>Taste<br>Knowledge |
| Palmeri et al. (1998) | N = 65 adult professionals and paraprofessionals serving low-income populations<br><br>Men = 12, Women = 53<br><br>SES = low to mid | Focus groups | Cost<br>Time<br>Family customs/habits<br>Knowledge |
| Kearney et al. (1999) | N = 14, 331 adults (EU)<br><br>Men = 6702, Women = 7614<br><br>SES = unreported | In-person interview. Subjects asked to rank a list of 22 possible barriers to healthy eating | Time<br>Willpower<br>Busy lifestyle<br>Cost<br>Don’t want to change habits<br>Taste<br>Knowledge |

Table 1.1, cont.

| | | | |
|---|---|---|---|
| Lopez-Azpianzu et al. (1999) | N = 1009 adults (Spain)<br><br>Men = 424, Women = 585<br><br>SES = unreported | In-person interview. Subjects asked to rank a list of 22 possible barriers to healthy eating | Irregular work hours<br>Willpower<br>Unappealing foods |
| Holgado et al. (2000) | N = 14, 331 adults (Spain = 1009 vs. EU = 13,322)<br><br>Men = 6702, Women = 7614<br><br>SES = unreported | In-person interview. Subjects asked to rank a list of 22 possible barriers to healthy eating | Irregular work hours<br>Willpower<br>Busy lifestyle<br>Cost<br>Give up foods I like<br>Don't want to change habits |
| Faugier et al. (2001) | N = 126 nurses (Great Britain).<br><br>All female<br><br>SES = unreported | Survey | Shift patterns<br>Failure to take breaks |
| Dibsdall et al. (2003) | N = 680 adults (UK)<br><br>Men = 150, Women = 530<br><br>SES = low | 30-item (Likert) instrument addressing accessibility, affordability, and motivations to eat healthy | Cost<br>Transportation<br>Choice |
| Fowles & Feucht (2004) | N = 181 pregnant women.<br><br>SES = mid to high. | Barriers to Healthy Eating Scale, 18 Likert-type items | Unavailability<br>Expense<br>Inconvenience<br>Preferences<br>Difficulty engaging in healthy eating |

Table 1.1, cont.

| | | | |
|---|---|---|---|
| Kieffer et al. (2004) | N = 97 family members (men, women, and children).<br><br>SES = low | Focus groups | Cultural/familial traditions<br>Unfavorable taste of healthful foods<br>Lack of time |
| Eikenberry & Smith (2004) | N = 796 adults<br><br>Men = 302, Women = 494<br><br>SES = low | 43-item instrument composed of open- and closed-ended items pertaining to perceptions, motivations, barriers, and promoters of healthy eating | Time<br>Cost<br>Lazy/unmotivated to change habits<br>Discipline |
| James (2004) | N = 34 adults<br><br>Men = 19, Women = 21<br><br>SES = low | Focus groups | No sense of urgency<br>Social/cultural symbolism of certain foods<br>Poor taste of healthy foods<br>Expense of healthy foods<br>Lack of knowledge/information.<br>Loss of cultural heritage |
| Chatterjee et al. (2005) | N = 19 adults community center workers<br><br>Men = 3, Women = 16<br><br>SES = low | In-person interview | Lack of time<br>Choice of foods available<br>Lack of parental encouragement (in case of children) |

*SES = socioeconomic status.

Another common barrier to healthy eating is taste (Lappalainen et al. 1997, Kearney et al. 1999, Kieffer et al. 2004, James 2004) (Table 1.1). Indeed, taste has been shown to be a powerful influence on food selection (Glanz et al. 1998, Cox et al. 1999). Regarding this concept, the actual taste of “health food” is perceived as unfavorable, and so these foods are avoided. Consequently, foods that are perceived as more palatable than health foods are consumed instead. More often than not, the more palatable foods are energy-dense and nutrient poor (Glanz et al. 1998).

A lack of time to obtain/prepare healthful foods/meals has been reported frequently as a barrier to healthy eating (Lappalaine et al. 1997, Palmeri et al. 1998, Kearney et al. 1999, Holgado et al. 2000, Kieffer et al. 2004, Eikenberry et al. 2004, Chatterjee et al. 2005). Other barriers include a lack of knowledge/information of nutrition (Lappalaine et al. 1998, Palmeri et al. 1998, James et al. 2004), lack of self-control/willpower (Lappalaine et al. 1998, Kearney et al. 1998, Lopez-Azpianzu et al. 1998, Hodgado et al. 2000, Eikenberry & Smith 2004), lack of choice/availability of healthy food choices (Chatterjee et al. 2005, Dibsdall et al. 2003), no sense of urgency/desire to change habits (James 2004, Eikenberry et al. 2004), and reluctance to stray from cultural/familial traditions (James 2004, Kieffer et al. 2004, Palmeri et al. 1998).

Another widespread nutritional attitudinal concept is referred to as motivators for eating. The most common motivators for eating include emotional (anger, joy, fear, depression) and physiological cues (hunger, taste), and have been researched extensively in non-postpartum, adult populations (Table 1.2). Eating in response to emotional cues is typically referred to as ‘emotional eating.’ Research of emotional eating has suggests that subjects eat more under an emotional influence. This effect is pronounced when an individual experiences negative emotions, such as anger or sadness (Popkess-Vawter et al. 1998, Macht & Simons 2000, Hargreaves et al. 2002, Geliebter and Aversa 2003, van Strein & Owens 2003, de Lauzon et al. 2004). Additionally, emotional eating appears to be associated with a higher weight status (Cox et al. 1998, Macht 1999, Popkess-Vawter et al. 2000, Fassino et al. 2003). For example, Cox et al. (1998) reported that obese individuals had higher emotional eating subscale scores compared to normal weight participants. Similarly, Macht (1999) found that study subjects are more during negative emotions, and that emotional eating was positively correlated with BMI.

Taste (Cox et al. 1999, Snoek et al. 2004, Glanz et al. 1998) and hunger (Cornier et al. 2004, Dykes et al, 2004, Provencher et al. 2003, Federhoff et al. 1998, Boschi et al. 2001) also are powerful motivators for eating. However, only hunger appears to be related to an unhealthy weight status (Cornier et al. 2004, Dykes et al. 2004, Provencher et al. 2003, Federhoff et al. 1998, Cox et al. 1999). Two recent studies measured susceptibility to hunger (food consumption in response to feelings of hunger) via the Three Factor Eating Questionnaire (TFEQ) (Stunkard and Messick 1985). In a sample of 244 men and 325 women, Provencher et al. (2003) found that obese subjects were more susceptible to hunger than the nonobese. This result was also reported by Boschi et al. (2001) in a sample of 93 women.

Many researchers have assessed emotional eating via the Three Factor Eating Questionnaire (TFEQ, Stunkard and Messick 1985) (Table 1.2). The TFEQ was

**Table 1.2.** Motivators for eating.

| Study | Motivation for eating/ Instrument | Subjects | Findings |
|---|---|---|---|
| Federoff et al. (1997) | Sensory/physiological<br><br>Revised Restraint Scale (Polivy et al. 1988) | N = 91 adult women (Canada)<br><br>SES* unreported | Levels of hunger higher in ‘restrained eaters’ vs. ‘unrestrained eaters’ |
| Popkess-Vawter et al. (1998) | Emotional<br><br>Interview: motivational states before, during, and after eating | N = 15 normal weight and 30 overweight/obese adult women (England)<br><br>SES unreported | A greater percentage of overweight/obese vs. normal weight women reported overeating preceded by unpleasant feelings (loneliness, fear, anger, depression |
| Cox et al. (1998) | Emotional<br><br>Dutch Eating Behavior Questionnaire (DEBQ) (van Strien et al. 1986) | N = 20 normal weight and 23 obese adults (England)<br><br>Men = 9, Women = 34<br><br>SES unreported | Obese subjects scored significantly higher for emotional eating |
| Glanz et al. (1998) | Sensory/physiological<br><br>Survey: influences on food choices and eating | N = 2,967 adults<br><br>SES unreported | Respondents reported that taste is the most important influence on their food choices |

Table 1.2, cont.

| | | | |
|---|---|---|---|
| Cox et al. (1999) | Sensory/physiological<br><br>DEBQ | N = 41 normal weight and 35 obese adults (England)<br><br>SES unreported | No differences between taste and weight groups |
| Macht (1999) | Emotional<br><br>Three Factor Eating Questionnaire (TFEQ) (Stunkard and Messick 1985) | N = adults (Germany)<br><br>Men = 103, Women = 107<br><br>SES unreported | Subjects reported eating more during negative emotions; correlated positive with body mass index |
| Macht and Simons (2000) | Emotional<br><br>Eating-Behavior and Weight-Problem Inventory (Diehl and Staufenbiel 1994) | N = 23 adult women (Germany)<br><br>SES unreported | Analysis revealed three types of emotional states: 'Anger-Dominance', 'Tension/Fear' and 'Relaxation/Joy'. Motivation to eat increased with negative emotions |
| Popkess-Vawter et al. (2000) | Emotional<br><br>Overeating Tension Scale | N = 62 normal weight and 68 obese adult women<br><br>SES unreported | Overweight group reported higher levels of overeating tension than normal weight subjects, particularly with negative emotions |
| Boschi et al. (2001) | Sensory/physiological<br><br>TFEQ | N = 37 obese, 42 overweight, and 14 normal weight women (Italy)<br><br>SES unreported | Hunger scores higher among obese than normal weight subjects |

Table 1.2, cont.

| | | | |
|---|---|---|---|
| Hargreaves et al. (2002) | Emotional<br><br>Focus groups: how personal and contextual factors contribute to food choices | N = 40 adult women<br><br>SES unreported | Statements obtained from focus group; categories included 'negative emotional eating', 'positive emotional eating', 'eating less when emotional' |
| Fassino et al. (2002) | Emotional<br><br>Eating Disorder Inventory (EDI) (Garner et al. 1983) | N = 103 obese and 93 normal weight adult women (Italy)<br><br>SES unreported | Depression associated with binge eating in obese subjects, but not in healthy controls |
| Provencher et al. (2003) | Sensory/physiological<br><br>TFEQ | N = 596 middle-aged adults (Canada)<br><br>SES unreported | Hunger positively correlated with BMI |
| van Strien and Owens (2003) | Emotional<br><br>DEBQ | N = 31 obese adult women (Netherlands)<br><br>SES unreported | Emotional eating positively correlated with food consumption |

Table 1.2, cont.

| | | | |
|---|---|---|---|
| Geliebter and Aversa (2003) | Emotional<br><br>Likert-type scale: eat more or less to various emotional states | N = 30 underweight, 30 normal weight, and 30 overweight adults<br><br>Men = 45, Women = 45<br><br>SES unreported | Overweight subjects reported eating more than under- and normal weight subjects in response to negative emotional cues |
| Elfhag et al. (2003) | Emotional<br><br>Rorschae Comprehensive System (CS) (Exner 1991, 1993) | N = 100 obese adults (Sweden)<br><br>Men = 24, Women = 76<br><br>SES = 66 low income | Negative emotions associated with binge eating and irregular meal patterns |
| de Lauzon et al. (2004) | Emotional<br><br>TFEQ | N = 529 mid-aged adults and 358 teens (France)<br><br>SES unreported | Emotional eating positively correlated with consumption of high-energy foods, greater in adult and teen women than men |
| Cornier et al. (2004) | Sensory/physiological<br><br>TFEQ | N = 13 normal weight and 9 obese adults<br><br>Men = 10, Women = 12<br><br>SES unreported | Obese subjects reported stronger feelings of hunger before and after meal consumption than lean individuals |

Table 1.2, cont.

| | | | |
|---|---|---|---|
| Dykes et al. (2004) | Sensory/physiological<br><br>TFEQ | N = 74 underweight, 603 normal weight, 529 overweight, 265 obese adult women (UK)<br><br>SES = mixed | Hunger positively associated with BMI classification |
| Snoek et al. (2004) | Sensory/physiological<br><br>Survey | N = 21 obese and 23 normal weight women (Netherlands)<br><br>SES unreported | No differences in taste and foods eaten between weight groups |

*SES = socioeconomic status

originally developed for use in French obese persons to measure an individual's ability to restrain themselves from overeating, their propensity for uncontrolled eating, and eating as a means of coping with emotional stressors. Another commonly used tool in the study of emotional eating is the Dutch Eating Behavior Questionnaire (DEBQ, van Strien et al. 1986). This instrument is contains a series of questions which respondents answer with regards to dietary restraint, as well as emotional and external influences associated with eating. The DEBQ was developed for use in Dutch adult populations, and thus far has only been implemented in Dutch studies. Although the TFEQ and the DEBQ may be effective measures of emotional eating, they may not be suitable for use in low-income and minority women during the first postpartum year.

To date, the study of nutrition attitudes during postpartum and their relationship to weight status has been limited to eating disorders (Table 1.3). In these studies, pre-existing instruments designed specifically for measuring symptoms of eating disorders were used. For example, in 1996 Stein and Fairburn (1996) administered the Eating Disorder Examination (EDE, Fairburn & Cooper 1993) to women of varied socioeconomic levels in the United Kingdom to document concerns about eating, weight and body shape. These concerns increased from 3 to 6 months after. Although EDE scores were not compared to weight, the inclusion of weight as a covariate in the analysis mitigated changes in EDE scores. In 1999 Baker et al. (1999) implemented the Eating Attitudes Test (EAT, Garner & Garfinkel 1979) to discern attitudes such as preoccupation with shape and fattening foods, binge and purging behaviors, and self control. The sample consisted of pregnant women, who were primarily non-Hispanic white, married, and middle class. Concerns for weight and shape increased from pregnancy to postpartum and weight/shape satisfaction was negatively associated with body mass index at 4 months postpartum. In 2000 Carter et al. also employed the EAT to determine relationships with BMI and symptoms of depression and anxiety during postpartum. Eating attitudes were associated with depression and anxiety at 14 months postpartum, but not to BMI, in primarily non-Hispanic White, married, middle class women. Collectively, these studies explain attitudes in postpartum *related only to eating disorders*. However, none of these studies of nutrition attitudes during postpartum were done in low-income populations.

**Table 1.3: Summary of nutrition attitudes in postpartum women.**

| Study | Instrument | Subjects | Time postpartum | Results |
|---|---|---|---|---|
| Stein and Fairburn (1996) | Eating Disorder Examination (EDE) (Fairburn and Cooper, 1987). 62-item (Likert scale) clinical interview that measured psychopathology of eating disorders. E.g.: concerns about eating, weight and body shape | N = 97 adult women (United Kingdom)<br><br>SES* = variable | 3 and 6 months | Concerns increased from 3 to 6 months postpartum. EDE scores not compared to weight |
| Baker et al. (1999) | Eating Attitudes Test (EAT) (Garner and Garfinkle, 1979). 40-item (Likert scale) instrument that identified abnormal eating patterns. E.g.: preoccupation with shape and fattening foods, binge and purging behaviors, and self control | N = 90 adult women, primarily non-Hispanic White, married<br><br>SES = mid – high | Pre-pregnancy, 4 months | Concerns for weight and shape increased from pregnancy to postpartum, and were negatively associated with body mass index (BMI) at 4 months postpartum |

Table 1.3, cont.

| | | | | |
|---|---|---|---|---|
| Carter et al. (2000) | EAT (described above) (Garner and Garfinkle, 1979) | N = 64 adult women, primarily non-Hispanic White, married<br><br>SES = mid – high | 4 and 14 months | Eating attitudes associated with depression and anxiety at 14 months postpartum, but not to BMI |

*SES = socioeconomic status

## NUTRITION KNOWLEDGE

The second aim of this research is to determine the degree of nutrition knowledge in low-socioeconomic status women in early and late postpartum and to discern its influence on weight retention at 1 year postpartum. In addition, an instrument for measuring nutrition knowledge will be developed and validated.

A review of the literature indicates that low-income populations have inferior nutrition knowledge to their higher income counterparts (Morton and Guthrie 1997, Parmenter et al. 2000, Dallongeville et al. 2000, Boulanger et al. 2002, Obayashi et al. 2003, Hakeem et al. 2004, Inglis et al. 2005, Lin and Lee 2005). Specific areas of low nutrition knowledge among low-income groups include diet/disease relationships (Winkleby et al. 1997, Morton and Guthrie 1997, Harnack et al. 1998, Parmenter et al. 2000, Obayashi et al. 2003, Klohe-Lehman et al. 2006), the Food Guide Pyramid (Morton and Guthrie 1997, Fowles et al. 2002, Boulanger et al. 2002, Klohe-Lehman et al. 2006), vitamins and minerals (Boulanger et al. 2002), nutrient content of foods (Campbell et al. 1999, Obayashi et al. 2003, Klohe-Lehman et al. 2006), and recommended number of servings of food (Fowles et al. 2002, Parmenter et al. 2000, Havas et al. 1998, DHKS 1994, Domel et al. 1992a, Domel et al. 1992b). For example, Morton and Guthrie (1997) reported that low-income adults (n = 758) were less likely to agree that diet had an influence on physical health (55%) compared to higher income participants (n = 1,121, 59%), and were less knowledgeable of the recommended number servings of vegetables (44% vs. 51%, $P < 0.05$), grains (2% vs. 9%, $P < 0.05$), and dairy (52% vs. 56%, $P$ = ns).

These findings are of concern as many studies indicate that poor nutrition knowledge is associated with unhealthful dietary behavior (Winkleby et al. 1997, Sun et al. 1999, Dallongeville et al. 2000, Fang et al. 2005, Klohe-Lehman et al. 2006). In 1997, Winkleby et al. (1997) administered an intervention of 24 classes designed to improve dietary quality to a sample of low-literacy adults (n = 113). Subjects were grouped as successful if they consumed < 30% total energy from fat at 3 months post-intervention. Successful participants (n = 34) had a greater increase in knowledge of nutrition topics covered in class from baseline to post-intervention (54.1% vs. 67.2%, $P < 0.01$) than non-successful subjects (data not given). In 2000, Dallongeville et al. (1999) examined whether nutrition knowledge was associated with dietary behavior in middle-aged men (n = 361) at risk for coronary heart disease; nutrition knowledge was measured via a 10-item quiz of foods/nutrients related to coronary heart disease. The high-score group (> 7 items correct, n = 59) more often consumed olive oil (36% vs. 12%, $P < 0.10$) and cereals (27% vs. 15%, $P < 0.05$), and less often consumed of sunflower oil (51% vs. 68%, $P < 0.05$) than the low-score men (≤ 4 items correct, n = 41). High-scoresubjects also had lower intakes of fat (89 g/d vs. 104 g/d, $P < 0.05$).

A higher level of nutrition knowledge also appears to be associated with greater weight loss among adult men and women (Jeffery & Wing 1995, Rhodes et al. 1996, Jalil et al. 2004, Menza et al. 2004), and a healthful weight status of low- to high-income men (Tomey et al. 2005). Jalil et al. (2004) administered a 12- week program to 60 obese adults that included dietary instructions, counseling and physical activity. The expected increase in nutrition knowledge corresponded with a 6% weight loss. In a year-long, weight control program of nutrition and exercise, Menza et al. (2004) observed that 20 overweight and obese had increased nutrition knowledge and lost more weight than controls, but direct comparisons of knowledge to weight were not reported.

Furthermore, similar findings have been reported in non-postpartum, low-income women (Domel et al. 1992a, Domel et al. 1992b, Klohe-Lehman et al. 2006). To illustrate, two separate reports by Domel et al. (1992a, 1992b) found that greater nutrition knowledge was negatively associated with BMI in low-income Hispanic (1992a) (n = 34) and non-Hispanic black women (1992b) (n = 45) after an 11-week nutrition education and behavioral modification program. A similar finding was recently reported by Klohe-Lehman et al. (2006). In their study, low-income, overweight/obese women (n = 141) received an 8-week weight loss intervention which instructed subjects on dietary behavior, physical activity and behavioral modification. Subjects were grouped according to post-intervention weight loss as responders (n = 66, loss of ≥ 2.27 kg) non-responders (n = 75, loss of < 2.27 kg), or weight gainers (n = 21). Responders had a higher total knowledge score than both responders and gainers at pre- (64% vs. 56% and 52%, respectively, $P < 0.05$) and post-intervention (80% vs. 68% and 64%, respectively, $P < 0.05$). All of the studies previously mentioned involved interventions which undoubtedly improved nutrition knowledge. The present study will be purely observational so that any changes in knowledge from early to late postpartum can be valuated without directly influencing those changes.

Studies utilizing only *postpartum* women also indicate that nutrition knowledge may be beneficial for weight reduction in well-educated, non-Hispanic White adults

(Leermakers et al. 1998, O'Toole 2003). At 6 – 18 months after receiving instructions to reduce fat and energy intake and increase physical activity, Leermakers et al. (1998) reported that women who received the intervention lost more weight than controls (7.8 kg vs. 4.9 kg, $P < 0.05$, respectively). Decreases in weight retention from 12 (O'Toole et al. 2003) to 18 months after childbirth were observed in women who were exposed to a diet and behavioral modification intervention. In both studies, nutrition knowledge was not measured, and participants were primarily well-educated Non-Hispanic Whites, as opposed to our tri-ethnic, low-income mothers.

While there are several instruments designed to assess nutrition knowledge, few are appropriate for use in low-income and minority women during postpartum. A summary of instruments designed to measure nutrition knowledge since 1978 is shown in Table 1.4. Many of these were designed to assess a broad range of concepts in nutrition, referred to as general nutrition knowledge (Parmenter & Wardel 1999, Stafleu et al. 1996, Frederick et al. 1992, Anderson et al. 1988, Graves et al. 1982, Grotkowski et al. 1978, Werblow et al. 1978). Others measured more specific concepts, such as nutrient content of foods (Obayashi et al. 2003, Boulanger et al. 2002, Matvienko et al. 2001, Sapp & Jensen 1997), diet/disease relationships (Obayashi et al. 2003, Papakonstantinou et al. 2002, McDougall et al. 1998, Sapp & Jensen 1997, Steenhuis et al. 1996), the Food Guide Pyramid (Boulanger et al. 2002, Matvienko et al. 2001), and food labels (Papakonstantinou et al. 2002, Matvienko et al. 2001). The majority of these instruments were developed and validated for use in adult men and women of non-specific SES (Obayashi et al. 2003, Papakonstantinou et al. 2002, Parmenter & Wardel 1999), Resnicow et al. 1997, Sapp & Jensen 1997, Steenhuis et al. 1996, Shepard et al. 1987). Others were designed to target more specific segments of the population, such as children (Anderson et al. 2002, Graves et al. 1982); teenagers (McDougall 1998); college students (Matvienko et al. 2001, Werblow et al. 1978); women with diabetes (Miller & Achterberg) or at risk for cardiovascular disease (CVD) (Rhodes et al. 1996); medical in-patients (Hawkes & Nowak 1998, Anderson et al. 1988); and the elderly (Colleen et al. 1991). Of all the above mentioned instruments, none were used or validated in postpartum populations.

| **Table 1.4** Nutrition knowledge instruments. | | |
|---|---|---|
| **Study** | **Target population** | **Scope of knowledge** |
| Werblow et al. (1978) | College women athletes | General nutrition |
| Grotkowski et al. (1978) | Elderly | General nutrition |
| Freeland-Graves et al. (1982) | Adults | General/vegetarian nutrition knowledge |
| Graves et al. (1982) | Elementary school children | General nutrition |
| Shepard et al. (1987)* | Adults | Fat consumption |
| Anderson et al. (1988) | Medical in-patients | General nutrition |
| Colleen et al. (1991) | Adults aged ≥ 60 yrs | Fat, fiber, salt |
| Frederick et al. (1992) | Adult women | General nutrition |
| Bergman et al. (1992) | Adult women | Caffeine |
| Plous et al. (1995) | Cardiac in-patients | Dietary fat, cholesterol, sodium, fiber |
| Stafleu et al (1996) | Adults (Dutch) | General nutrition |
| Rhodes et al. (1996) | Adult women at risk for CVD | Dietary fat and fiber, healthful food choices, diet/disease relationships |
| Steenhuis et al (1996) | Adults (Dutch) | Fat content, diet/health relationships |
| Sapp & Jensen (1997). | Adults | Nutrient content of foods, diet/health relationships. |
| Resnicow et al (1997) | Adult consumers | Dietary fat, fiber, and cholesterol |

Table 1.4, cont.

| | | |
|---|---|---|
| Resnicow et al (1997) | Adult consumers | Dietary fat, fiber, and cholesterol |
| Hawkes & Nowak (1998) | Cardiac patients | Knowledge relating to fat and cholesterol |
| Miller & Achterberg (1999) | Adult women with diabetes | Food labels |
| Parmenter & Wardel (1999) | General public | General knowledge |
| Campbell et al. (1999)* | Low-income women | Low-fat foods, fast/snack foods |
| Warber et al. (2000) | Nurse practitioners | Basic applied nutrition, role of nutrition in prevention of cardiovascular disease, food labels, nutritious food selection |
| Matvienko et al. (2001) | College students | Nutrient content of foods, FGP, food labels, recommendations |
| Papakonstantinou et al. (2002) | Adult consumers | Diet/disease relationships, food labels |
| Anderson et al. (2002) | N = 98 children age 11 | Applied nutrition, food preparation. |
| Boulanger et al. (2002) | Low-income Latino caretakers. | Saturated fat, vitamins and minerals, folic acid, cholesterol, and general health. |
| Navia et al. (2003) | University students | Recommended servings of foods |
| Obayashi et al. (2003) | Adult consumers (age ≥ 20 yrs). | Nutrient content of foods, diet/disease relationships. |
| Abood et al. (2003) | Adult university staff | Nutrition related to cardiovascular disease and cancer risk: protein, fat, carbohydrates, cholesterol, recommended servings of fruits and vegetables, dietary fat reduction |

TAble 1.4, cont.

| | | |
|---|---|---|
| Abood et al. (2004) | Female college athletes | 42 true/false statements regarding total energy, carbohydrates, fat, protein, calcium, iron, zinc |
| Dallongeville et al. (2000) | Middle-aged men (France) | Foods and nutrients involved in coronary heart disease risk control |
| Rasanen et al. (2004) | Families (Finland) | Finish nutritional recommendations, types and food content of fat, dietary sources and amounts of salt |
| Charlton et al. (2004) | Low-income adult women (Africa) | Function and food sources of vitamin A and iron, protein, recommended servings of fruits and vegetables |
| Menza et al. (2005) | Adults with schizophrenia (Netherlands) | Weight management, meal planning, label reading, food shopping and preparation, portion sizes, healthy snacking |
| Klinedinst et al. (2005) | Elderly adults aged 75 y | Salt content of foods, reducing dietary fat and cholesterol, diabetes |
| Lin & Lee (2005) | Elderly adults aged > 65 y | 48 items (true/false, multiple choice, open-ended) related to diet/disease relationships, food group requirements, nutrient content of foods |
| Klohe-Lehman et al. (2006) | Low-income overweight/obese mothers (child age 8 months -12 yrs) | Nutrition and weight loss, heart disease, prenatal nutrition, child nutrition, Food Guide Pyramid, food sources and functions of macronutrients, vitamins and minerals |
| *Used individual items only | | |

**DIETARY BEHAVIOR AND POSTPARTUM WEIGHT STATUS**

The third aim of this research is to determine the level and adequacy of nutrient intakes of low-income and minority women and discern any associations to weight status at 1 year postpartum.

Minority and low-SES women in the U.S. are at an increased risk for nutritional inadequacy. Recent studies have shown that the diets of these women are lacking in recommended servings for grains (George et al. 2005, Sharhar et al. 2003, Bodnar et al. 2002a, Haines et al. 1999); fruits and vegetables (Lancaster et al. 2006, George et al. 2005, Thompson et al. 2005, Satia et al. 2005, Bodnar et al. 2002a, Haines et al. 1999); fiber (Lancaster et al. 2006, Howarth et al. 2005, Thompson et al. 2005); protein (Sharhar et al. 2003); dairy products (George et al. 2005a, Ranganathan et al. 2005, Sharhar et al. 2003); and many vitamins and minerals. These include calcium (Sharhar et al. 2005, Satia et al. 2005, Arab et al. 2003, Huang et al. 2002, Siega-Riz & Popkin 2001); iron (Sharhar et al. 2005, Bodinar et al. 2002, Huang et al. 2002, Siega-Riz & Popkin 2001, Haines et al. 1999); and zinc and folate (Sharhar et al. 2005, Bodinar et al. 2002, Siega-Riz & Popkin 2001). Conversely, diets of this population tend to be excessive in total energy (Lancaster et al. 2006, Diaz et al. 2005, Neuhouser et al. 2004, Kristal et al. 1999), with a higher than recommended % energy from fat (Lancaster et al. 2006, George et al. 2005b, Diaz et al. 2005, Havas et al. 2003). This last finding is of particular concern, as a high-fat diet has been associated with overweight and obesity (Howarth et al. 2005, Sharhar et al. 2005, Kant et al. 2005, Crowe et al. 2004). Furthermore, cardiovascular disease, hypertension, type 2 diabetes, osteoporosis, diverticulosis, iron deficiency anemia, and some cancers have been linked to a poor diet.

Studies of dietary behavior in *postpartum* women have described trends of nutritional inadequacy from early to late postpartum (Table 1.5). At one month postpartum, Butte and her colleagues (1981) studied dietary intakes in a sample of 87 women. They reported that median intakes of calcium (578 mg), magnesium (212 mg), zinc (11.7 mg), copper (1.44 mg), vitamin A (2488 international units [I.U.]), vitamin D(116 I.U.), vitamin E (3.5 mg), $B_6$ (1.33 mg), biotin (46 µg), and folate (134 µg) were below 60% of the RDAs. At 6 weeks postpartum, Heck and Castro (1993) compared food intakes of non-overweight/obese women (n = 14) to those of non-postpartum women matched for age and BMI (n = 14). Daily intakes were below the RDAs for total energy (62%), calcium (60%), magnesium (71%), and zinc (48%). At 2 – 4 months postpartum, Black et al. (1986) reported that subjects (n = 63) had dietary values below the RDAs for zinc (48%), vitamin $B_6$ (50%), folate (41%), and biotin (21%). At 3 months postpartum, a Canadian study of 183 lactating women found nutrient values below the RDA for total energy (2,148 kcal vs. 2,700 kcal), calcium (928 mg vs. 1200 mg), folate (222 mg vs. 280 µg), iron (13 mg vs. 15 mg), thiamin (1.4 mg vs. 1.6 mg), vitamin A (846 retinol equivalents [R.E.] vs. 1300 R.E.), and zinc (10 mg vs. 19 mg) (Doran & Evers 1997). At 6 months postpartum, George et al. (2005a) observed in a sample of 149 women in the southwestern U.S. that < 40% of subjects consumed the recommended servings of vegetables, fruits, dairy, and fats. In India, Agrakar-Murugkar

**Table 1.5.** Summary of dietary behavior studies in postpartum women

| **Study** | **Sample** | **Diet Assessment Method** | **Time Points Assessed** | **Nutrients and Results** |
|---|---|---|---|---|
| Butte et al. (1981) | N = 87 lactating<br><br>SES[a] = low | 24-hr recall | 1 month postpartum | Median nutrient intakes less than 60% the RDA[b] for calcium, zinc, magnesium, copper, vitamins A, D, E, $B_6$, biotin, and folate |
| Finley et al. (1985) | N = 60 lactating vegetarians<br><br>SES = low | 24-hr recall & 2-day diet records | Range of 1 to 26 months postpartum | Mean intakes of vitamins (A, B1, B2, niacin, C) and minerals (calcium, phosphorus, iron, sodium, potassium) ranged from 89 – 154% RDA |
| Song et al. (1985) | N = 46 lactating<br><br>SES = mid/high | 24-hr recall & 2-day diet records | 2 weeks and 3 months postpartum | Mean intakes met or exceeded RDAs for total energy, protein, fat, carbohydrates, calcium, magnesium, phosphorus, vitamins (A, B1, B2, niacin, B12, C, folate) and minerals (iron, potassium, zinc) |
| Black et al. (1986) | N = 63 lactating (United Kingdom)<br><br>SES = mid/high | 4-day diet records | 2 – 4 months lactation, 3 – 6 months post-lactation | Mean intakes met/exceeded *UK* RDAs for vitamins (B1, B2, B6, B12, niacin, C, E, retinol, beta-carotene, pantothenic acid) and minerals (calcium, phosphorus, magnesium, zinc), except iron (85% RDA) and vitamin D (75% RDA). Mean intakes met/exceeded *US* RDAs for phosphorus and B12 only |
| Carbone et al. (1992) | N = 36 (lactation unreported) (Spain)<br><br>SES unreported | 3-day diet records | 12 – 36 weeks gestation, 40 days postpartum | Mean zinc intake at 20 weeks gestation 66% RDA, and 52% at 40 days postpartum |

Table 1.5, cont.

| | | | | |
|---|---|---|---|---|
| Heck & Castro (1993) | N = 14 lactating<br><br>SES = low | 7-day food diary | 6 weeks postpartum | Mean intakes ≥ RDA for protein (116%), iron (110%), phosphorus (100%), niacin (106%), vitamins C (233%), E (254%), and B12 (204%). Mean intakes below RDA for total energy (62% RDA), calcium (59%), magnesium (71%), and zinc (48%). |
| Todd & Parnell (1994) | N = 73 lactating (New Zealand)<br><br>SES unreported | 24-hr recall X 2 | 3 months postpartum | Mean total energy 80% that of Australian recommended nutrient intakes (RNI). Mean intakes of zinc, calcium, folate, and vitamin A below 60% RNI |
| Mackey et al. (1998) | N = 52 lactating<br><br>SES unreported | 2-day food records | 3 and 6 months postpartum | Mean intakes < 70% RDA for total energy , zinc, vitamins D and E at 3 and 6 months, and calcium and folate at 6 months |
| Doran and Evers (1997) | N = 183 lactating (Canada)<br><br>SES = low to mid | 24-hr recall | 3 months postpartum | Median intakes below RDA for total energy (80% RDA), calcium (77%), folate (79%), vitamin A (65%), iron (87%), thiamin (88%), and zinc (53%) |
| Morin et al. (1999) | N = 67 (17 breastfeeding, 28 bottle feeding, 17 feeding method unavailable)<br><br>SES = low | 24-hr recall | 24 hrs, 1, 2, and 4 months postpartum | Obese subjects at 24-hrs (n=24), 1 (n=17), 2 (n=13), and 4 (n=15) months postpartum consumed > 30% total energy from fat. Folate below RDA for overweight and obese at all time points (range 17-38% RDA and 9-43% RDA, respectively) |
| Berg et al. (2001) | N = 15 non-lactating<br><br>SES = mid/high | 7-day food records | Pregnancy and 6 months postpartum | Mean intakes from prepregnancy to 6 months postpartum of increased for folate (58% vs. 64% RDA), and decreased for zinc (90% vs. 69% RDA) and B12 (263% vs. 177% RDA) |

Table 1.5, cont.

| | | | | |
|---|---|---|---|---|
| Chan et al. (2001) | N = 13 anemic and (5 non-lactating, 8 lactating) and 34 non-anemic (12 non-lactating, 22 lactating) (China)<br><br>SES unreported | 24-hr recall and 3-day food records | 0, 2, 6 weeks, 3 and 6 months postpartum | Average percentage of anemic subjects < 60% RDA for iron and vitamin C were 22% and 33%, respectively. Average percentage of non-anemic subjects < 60% RDA for iron and vitamin C were 14% and 20%, respectively |
| Agrahar-Murugkar & Pal (2004) | N = 482 low-income and 253 high-income (lactating: 210 and 253 respectively (India)<br><br>SES = low and high | 24-hr recall, food frequency questionnaire | 0-6 months postpartum | Mean dairy intake (11.9 g/d) of all subjects lower than RDA. Fruit consumption (20.3 g/d) adequate compared to RDA. Meat consumption (10.5 g/d) below RDA. Calcium intake 31% RDA. Total energy (2187 kcal/d) lower than RDA for low-income, lactating women |
| Ayatollahi (2004) | N = 266 lactating (India)<br><br>SES = mixed | 24-hr recall, food frequency questionnaire | Unspecified | Percent RDA for protein (120%), iron (87%), calcium (88%), and vitamin C (164%) |
| Olson et al. (2005) | N = 360 (173 lactating < 1y, 88 lactating ≥ 1 y, 99 unknown)<br><br>SES = low (n=119) and mid/high (n=230) | Food frequency questionnaire | Prepregnancy, pregnancy, 6 months postpartum, 1 and 2 years postpartum | At all time points, less than 40% of the sample did not consume ≥ 2 cups of milk per day or ≥ 3 fruits and vegetables per day. Mid/high-income women more likely than low-income to consumed ≥ 3 servings of fruits and vegetables. Proportion of subjects who consumed ≥ 3 fruits and vegetables greater at 2 years vs. prepregnancy |

Table 1.5, cont.

| | | | | |
|---|---|---|---|---|
| George et al. (2005a) | N = 149 (27 lactating)<br><br>SES = low | Food frequency questionnaire | Prepregnancy, 6 months postpartum | At all time points, less than 40% of all subjects consumed the recommended number of servings of grains, vegetables, fruit, dairy, fat, and added sugar. At 6 months, lactating had more servings of vegetables (2.6) and fruit (2.2) compared to non-lactating (1.8 and 1.6) |
| George et al. (2005b) | N = 146 non-lactating<br><br>SES = low | Food frequency questionnaire | 1 year postpartum | 60% consumed the recommended servings of meat. Less than 30% consumed the recommended servings of grains, vegetables, fruit, dairy, fats, and added sugar |

[a]SES = socioeconomic status
[b]RDA = recommended daily allowance

and Pal (2004) compared nutrient intakes to the RDAs for India in 650 women who were 6 months postpartum. They found that consumption of total energy (2,187 kcal/d), dairy products (11.9 g/d), meats (10.5 g/d), and calcium (309.4 g/d) were below government guidelines.

Subsequent work by George and her colleagues (2005b) assessed dietary behavior in the non-lactating, low-income women (n=146) in the U.S. at 1 year postpartum. Few subjects were in compliance with the recommended number of servings of grains (23.3%), vegetables (16.4%), fruits (25.3%), and dairy (19.9%). More than two-thirds did not achieve the recommendation of ≤ 30% total energy from fat. Virtually the entire sample (99.3%) reported intakes below recommended servings of whole grain foods each day. Similarly, Olson et al. (2005) observed that only one-third of subjects consumed recommended servings of milk that were ≥ 2 cups/d and fruit and vegetable servings that were ≥ 3 per day at 1 year postpartum. These figures did not change significantly at 2 years postpartum.

One reason why so many women fail to achieve dietary recommendations during postpartum may be due to the fact that the standards are higher for lactating women. The majority of studies summarized in Table 1.5 are of lactating populations. Of these, four have made a direct within-sample comparison according to lactation status (Heck & Castro 1993, Agrahar-Murugkar and Pal 2004, Olson et al. 2005, George et al. 2005a). In 1993, Heck and Castro (1993) compared food intakes of normal weight, lactating women at 6 weeks postpartum to those of non-pregnant, non-lactating women matched for age and BMI. Daily intakes of lactating women were below the RDAs for total energy, calcium, magnesium, and zinc, and significantly lower than non-lactating women for total energy (62% vs. 90% RDA, respectively, $P < 0.05$) and calcium (60% vs. 100%, $P < 0.05$). When compared to RDAs, women from India who lactated up to 6 months (n = 210) following child birth consumed less protein (81% vs. 112%), fat (27% vs. 65%), calcium (31% vs. 84%), iron (47% vs. 70%), beta-carotene (22% vs. 62%), and vitamin C (84% vs. 173%), than non-pregnant, non-lactating subjects (n = 220) (Agrahar-Murugkar et al 2004).

In contrast, other studies indicate that lactating mothers have comparatively enhanced dietary quality compared to those who do not (George et al. 2005a), or breastfed for a shorter duration of time (Olson et al. 2005). For example, George et al. (2005a) reported that women who lactated at 6 months were more likely to adhere to recommendations regarding fruits, vegetables, dietary fat, and added sugars. Olson et al. (2005) found that women who breastfed up to 1 year were more likely to have consumed $\geq 3$ servings of fruits and vegetables at prepregnancy, 6, and 12 months postpartum as compared to those who did not breastfeed as long. Collectively, these results suggest that the actual dietary nutritional adequacy of lactating women is inconclusive.

A lower SES may be a risk factor to poor dietary status during postpartum as numerous studies (Table 1.5) indicate that dietary quality decreases with SES, not only in the U.S. (Song et al. 1985, Olson et al. 2005), but, internationally, as well (Agrahar-Murugkar & Pal 2004). To illustrate, Olson et al. (2005) recently found that U.S. women of higher SES (n=230) more often consumed $\geq 3$ servings of fruits and vegetables a day than lower SES women (n=119) from prepregnancy to 2 years postpartum. Similarly, Agrahar-Murugkar & Pal (2004) observed that Indian subjects of high-SES (n=253) were more likely to achieve the RDA for total energy of 2725 kcal/day than low-SES participants (n=482) (2621 kcal/d vs. 2187 kcal/d, respectively, $P < 0.05$) at 6 months postpartum. Together, these findings identify low-income women as a high-risk group for nutritional inadequacy during the postpartum period.

Only one of the studies summarized in Table 1.5 compared dietary behavior to weight status during postpartum. In 1999, Morin et al. (1999) measured weight status and dietary behavior at 24 hours, 1, 2, and 4 months postpartum. At each time point, participants were classified by weight status as underweight (BMI < 19.8 kg/m2), normal weight (BMI $\geq$ 19.8 kg/m$^2$ and $\leq$ 26.0 kg/m$^2$), overweight (BMI > 26.0 kg/m$^2$ and $\leq$ 29.0 kg/m$^2$), and obese (BMI > 29.0 kg/m$^2$). At all time points obese subjects consumed > 30% of total energy from fat. Furthermore, folate intakes for overweight and obese participants were well below the RDA (range of 38% at 24 hours postpartum to 17% at 4 months postpartum, and 43% at 24 hours postpartum to 9% at 4 months postpartum, respectively). These results suggest an association of diet on postpartum weight status.

## Summary

Collectively, this literature review indicates that nutrition knowledge, attitudes, and diet may influence the amount of weight retained from pregnancy at one year after childbirth. However, the existing information is far from conclusive, particularly for women of low SES.  Thus, the overall goal of this research is to explore the influence of nutrition attitudes, knowledge, and diet on postpartum weight retention in low-income, minority women.

## Chapter 2: Influence of Nutrition Attitudes and Motivators for Eating on Postpartum Weight Status in Low-Income New Mothers


### ABSTRACT

**Objective:** The purpose of the present study is to identify attitudes towards nutrition and their influence on weight status in low-income mothers in the first year postpartum.

**Design:** Nutrition attitudes were assessed at 1.5, 6, and 12 months postpartum. Body weight and height measurements were taken to calculate body mass index (BMI) at each time point. Nutrition attitudes at each time were compared to demographic variables and weight status.

**Subjects:** Subjects were 340 non-Hispanic White (31.3%), non-Hispanic Black (25.1%), and Hispanic (43.7%) new mothers (mean age, 22.4 years) located in central Texas. Criteria for participation included good health at delivery and low-income (≤ 185% Federal poverty guideline).

**Statistical Analyses:** $\chi 2$ tests were used to compare demographic groups to categorical variables. Multivariate analysis of variance was performed to investigate the effect of demographic variables on instrument subscale scores. A repeated measures analysis of variance was used to identify significant changes over time.

**Results:** Obese women at 1 year had higher barriers to healthy eating subscale averages than normal and overweight subjects at 1.5 and 6 months, and greater than overweight participants at 12 months. Obese individuals also had higher emotional eating subscale

scores than overweight women at 1.5 months and both normal and overweight subjects at 12 months.

**Conclusions:** Women who were obese at 1 year postpartum were more likely to perceive greater barriers to healthy eating and respond more to emotional cues to eat. Health professionals could emphasize potential changes and difficulties often faced in postpartum and identify techniques to overcome these obstacles to healthy eating.

## INTRODUCTION

The United States (U.S.) is experiencing an epidemic of obesity. In adults, the incidence has increased from 22.5% in 1994 to 30.6% in 2002 (Flegal et al. 1998, Must et al. 1999, Hedley et al. 2004). Women appear to be at a greater risk than men, particularly those of low socio-economic status, Hispanic and non-Hispanic Black ethnicity (Hedley et al. 2004, Mokdad et al. 2003, Kristal et al. 1999), and childbearing age (Hedley et al. 2004, Rooney et al. 2002, U.S. Department of Health, 2005). For many women, weight retained following pregnancy may be a significant factor in the development of overweight and obesity in later life (Linne et al. 2004, Lederman et al. 2002, Gunderson et al. 2000). This paper will explore whether attitudes towards nutrition and motivators for eating were related to weight status in the first year postpartum.

This topic has received little attention, particularly in low-income populations. The only studies of attitudes related to nutrition in postpartum have focused on those related to eating disorder pathology (Carter et al. 2000, Baker et al. 1999, Stein and Fairburn 1996). In 1996 Stein and Fairburn (1996) administered the Eating Disorder Examination (EDE, Fairburn and Cooper 1993) to 97 women of varied socioeconomic levels in the United Kingdom to document concerns about eating, weight and body shape. These concerns increased during the first 3 months after childbirth and stabilized during the next 3 months. Although EDE scores were not compared to weight, the inclusion of weight as a covariate in the analysis mitigated changes in EDE scores, implying an association. In 1999 Baker et al. (1999) used the Eating Attitudes Test (EAT, Garner and Garfinkel 1979) to discern attitudes such as preoccupation with shape and fattening foods, binge and purging behaviors, and self control. The sample of consisted of 90 pregnant women, who were primarily non-Hispanic White, married, and middle class. Concerns for weight and shape increased from pregnancy to postpartum and weight/shape satisfaction was negatively associated with body mass index (BMI) at 4 months postpartum. In 2000 Carter et al. (2000) also used the EAT to determine relationships with BMI and symptoms of depression and anxiety during postpartum. Eating attitudes were associated with depression and anxiety at 14 months postpartum, but not to BMI in 64 primarily non-Hispanic White, married, middle class women. Collectively, these studies explain attitudes in postpartum related only to eating disorders.

Motivators for eating, such as emotional (anger, joy, fear, depression) and physiological cues (hunger, taste), have been studied extensively in non-postpartum, adult populations (Elfhag et al. 2003, Geliebter and Aversa 2003, Macht 1999, de Lauzon et al. 2004, van Strien and Ouwens 2003, Hargreaves et al. 2002, Macht and Simons 2000, Popkess-Vawter et al. 1998, Fassino et al. 2003, Popkess-Vawter et al. 2000, Cox et al. 1998, Cornier et al. 2004, Dykes et al. 2004, Provencher et al. 2003, Fedoroff et al. 1997, Boschi et al. 2001, Cox et al. 1999, Snoek et al. 2004, Glanz et al. 1998). Research of emotional eating, or eating in response to an emotional cue (anger, joy, fear, depression), has shown that subjects eat more under an emotional influence, particularly during ‘negative’ emotions such as anger or sadness (Geliebter and Aversa 2003, de Lauzon et al. 2004, van Strien and Ouwens 2003, Hargreaves et al. 2002, Macht and Simons 2000, Popkess-Vawter et al. 1998). Furthermore, emotional eating has been associated with elevated weight status (Macht 1999, Fassino et al. 2003, Popkess-Vawter et al. 2000, Cox et al. 1998). Hunger (Cornier et al. 2004, Dykes et al. 2004, Fedoroff et al. 1997, Boschi et al. 2001, Cox et al. 1999) and taste (Cox et al. 1999, Snoek et al. 2004, Glanz et al. 1998) are indeed strong motivators for eating, yet only hunger appears to be related to obesity (Dykes et al. 2004, Provencher et al. 2003, Fedoroff et al. 1997, Cox et al. 1999). Two recent studies measured susceptibility to hunger (food consumption in response to feelings of hunger) via the Three Factor Eating Questionnaire (TFEQ) (Stunkard and Messick 1985). In a sample of 244 men and 325 women, Provencher et al. (2003) found that obese subjects were more susceptible to hunger than the nonobese. This result was also reported by Boschi et al. (2001) in a sample of 93 women.

The goal of the present study is to identify and measure nutrition attitudes and motivators of eating in the first year postpartum and to ascertain relationships with weight status. These concepts will be measured via a newly validated instrument that determines attitudes and barriers towards healthy eating, as well as motivators for eating. Low-income and minority women were chosen as subjects for this study as they represent a significant segment of the U.S. population who are overweight or obese. A secondary purpose was to compare associations of nutrition attitudes and motivators for eating with demographics and anthropometrics in order to discern subjects at risk for obesity.

## METHODS

### Study Design

Initially, a nutrition attitudes and motivators for eating scale was developed and validated in a sample of 134 low-income women at 1.5 months postpartum. Validity was established using principal component factor analysis (Waltz et al. 1991) and reliability was determined via Cronbach's alpha. The validated scale was tested in a second group of 206 women at 1.5, 6 and 12 months postpartum. Body weights were determined at each time point, and height, at 1.5 months. All participants were recruited in the hospital the day of/ day after giving birth to a healthy newborn. At the hospital, data were collected on sociodemographic (age, ethnicity, parity, education, marital status) and pregnancy (prepregnancy weight and gestational weight gain) variables. At each time point, nutrition attitudes and motivators for eating were compared to demographic variables and weight status.

### Subjects

A convenience sample was derived from the first 340 subjects of a larger observational study of new mothers during the first year postpartum (Walker et al. 2004). Each participant was informed of the nature of the study and signed consent forms approved by the Institutional Review Board at The University of Texas at Austin. Criteria for participation were: good health at delivery (free of pregnancy and childbirth complications and current illness); ≥18 years of age; parity of ≤ 3; ability to speak and read English; a healthy child at birth without complications; low-income (≤ 185% the

Federal guideline for poverty); and self-identified as Non-Hispanic White, Hispanic, or non-Hispanic Black. All subjects were eligible for enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

**Nutrition Attitudes Scale**

A 73-item (Likert scale ranging from 1 = strongly disagree/never to 7 = strongly agree/always) questionnaire was constructed to assess nutrition attitudes based on concepts from the literature. The initial version of the instrument was reviewed by a panel of nutrition experts for face validity, revised, and pilot-tested in the first group of postpartum women. Data reduction was performed by item and factor analyses [Principal Components Analysis (PCA)] to determine construct validity. Items were reverse-coded as needed. Criteria for item inclusion included: a kurtosis ratio $\geq 1$, item-to-total correlation of $\geq .30$, an $\alpha \geq .60$, factor loading of $\geq .40$ and loading on only one component. A Scree plot was also employed to determine the final instrument of 21 items contained in four distinct factors, labeled as 'healthy eating', 'perceived barriers to healthy eating', 'emotionally influenced eating', and 'sensory/physiological motivators for eating' (Table 2.2). The first factor, healthy eating, consisted of questionnaire items related to various aspects of healthy eating, such as choosing low-fat foods, using nutrition labels, and being concerned with the nutritional content of foods. The second factor, perceived barriers to healthy eating, contained items associated with obstacles to adopting or maintaining a healthful diet. These barriers included: changing eating habits, work, and unappetizing low-fat foods. Emotionally influenced eating related to how emotional states influenced eating behavior. The last factor, sensory/physiological motivators for eating, contained items that related to taste, hunger, and cravings.

To determine the internal reliability of the four subscales, Cronbach's alpha (Nunnaly 1978) for the factors were .84 for healthy eating, .77 for perceived barriers to eating healthy, .79 for emotionally influenced eating, and .65 for sensory/physiological motivators for eating. Mean subscale scores were obtained and used for the results presented in this study. Scores ranged from 1 – 7; higher subscales indicated that a participant felt that the construct in question was more of a factor in their lives while a lower score meant it was not relevant or lacked significance to the individual.

Five Likert-type items (1=disagree to7=strongly agree) that did not factor into one of the above subscales also are presented in survey form because of their interest. These included: 1) "How important is boredom in determining your motivation for eating?"; "Currently, what prevents you from eating as healthfully as you want to?" 2) Cost and 3) Time; 4)" My family would help me if I chose to lose weight;" 5)" I am confident that I will return to my prepregnancy weight."

## Weight, Height, and Lactation Status

Prepregnancy weight was self-reported at the hospital recruitment process. Postpartum weights were measured at each visit to the nearest 0.1 kg on a calibrated digital scale (Fairbanks Portable Digital Scale, Model No. HS100, Kansas City, MO). Height was measured (to the nearest 0.1 cm) using a stadiometer (Perspective Enterprises, Portage, MI). Body mass index was computed as kg/m$^2$. Normal weight was defined as BMI < 25; overweight as BMI 25-29.9, and obese, BMI ≥ 30. Lactation status was estimated by a lactation score assessed at 1.5, 6, and 12 months postpartum. The score consisted of 1= not lactating/bottle feeding only, 2 = combination breast/bottle feeding and 3 = breastfeeding only. Values from each time point were summed to yield the final score. A sum score of three (lowest) indicated that a participant did not lactate at all, while a sum score of nine (highest) meant that the subject breastfed exclusively throughout the year.

**Statistical Analysis**

The Statistical Package for Social Sciences (version 11.5, SPSS, Chicago, Ill) was used for data analysis. Data were entered into SPSS and checked for normality and accuracy. Means and frequencies were computed as descriptive statistics for demographic variables, weight categories, instrument subscale scores and survey responses. Pearson correlations were used to determine relationships between demographic variables, subscale, survey scores, and weight status. Chi-square tests were used to determine differences between groups on categorical variables. Multivariate analysis of variance (MANOVA) was performed to investigate the effect of demographic variables on all subscale scores. A repeated measures analysis of variance [via the general linear model (GLM) procedure] was used to identify significant changes in responses over time. Post-hoc (Tukey's significant difference test) and pairwise multiple comparisons (Bonferroni test) were performed to compare mean scores of demographic and weight status groups. The McNemar test was used to identify significant changes in response to individual survey items. Statistical significance was set at a $p$ value of $<0.05$ for all tests.

## RESULTS

### Demographics

The profile of the subjects is shown in Table 2.1. There were no differences in demographic variables between the validation and attitudes assessment groups. The average age was 22.2 ± 0.4 and 22.5±0.3 (mean±SEM) years for the validation and attitudes assessment groups, respectively. Hispanics accounted for 44% of both samples, and were nearly twice as likely to have not completed high school (60%) than non-Hispanic Whites (33%), and more than double that of Non-Hispanic Blacks (27%) ($\chi^2$=40.6, df=4, $p$<0.05). Approximately three-fourths of both samples had one or two children. Only one-fifth of all women had attended or graduated from college. Approximately two-thirds of all women were married/living with a partner. However, non-Hispanic Black women were more likely to be single (67%) than non-Hispanic Whites (39%) and Hispanics (30%).

### Weight and Lactation Status

The average prepregnancy BMI (kg/m²) and gestational weight gain for both the validation and study populations were 25.8±0.31 (mean±SEM) and 25.4±0.40 kg/m², respectively, and did not differ significantly between samples. Within the study population, age had a significant influence on prepregnancy BMI (F=3.9, $p$<0.05), as the youngest had lower weights. At one year postpartum, the mean BMI in the study populations increased to 28±0.5 kg/m$^2$ ($p$<0.05), with a mean weight gain of 6.0±0.6 kg (range of -14.0 kg to 42.4 kg) from prepregnancy. Approximately 40% were of normal

**Table 2.1.** Demographic characteristics of postpartum women (n=206).

| Characteristics | n | Percentage[a] |
| --- | --- | --- |
| **Age (years)** | | |
| 18 - 20 | 73 | 35.4 |
| 21 – 24 | 86 | 41.7 |
| > 24 | 47 | 22.8 |
| **Ethnicity** | | |
| Non-Hispanic White | 63 | 30.6 |
| Non-Hispanic Black | 57 | 27.7 |
| Hispanic | 86 | 41.7 |
| **Parity** | | |
| 1 | 78 | 37.9 |
| 2 | 78 | 37.9 |
| 3 | 50 | 24.3 |
| **Education** | | |
| No/some high school | 83 | 40.6 |

Table 2.1, cont.

| | | |
|---|---|---|
| High school graduate | 79 | 38.7 |
| Some college/college graduate | 42 | 20.6 |
| **Marital status** | | |
| Single, not living with partner | 81 | 39.5 |
| Married, living with partner[b] | 124 | 60.5 |

[a]Percentages are row percentages.

[b]Cohabitation with a partner was included as married.

**Table2. 2.** Factor loadings of the Nutrition Attitudes Questionnaire

| Factors | Factor 1 Healthy eating | Factor 2 Perceived barriers | Factor 3 Emotional eating | Factor 4 Sensory/ physiological motivators for eating |
|---|---|---|---|---|
| **Healthy eating** | | | | |
| Choosing low-fat foods is important to me now [a] | **.809** | .081 | -.026 | .123 |
| My diet as being low-fat [b] | **.750** | .042 | .085 | -.098 |
| I enjoy low-fat foods [b] | **.739** | -.005 | -.166 | -.157 |
| I use nutrition labels to help me select foods [b] | **.732** | .177 | .052 | .002 |
| Eating a healthy diet is important to me now [a] | **.703** | -.041 | .075 | .168 |
| I consider the Food Guide Pyramid in choosing my diet [b] | **.674** | .081 | .104 | .045 |
| My diet as being healthy [b] | **.645** | -.137 | .061 | -.098 |
| I am very concerned with the nutritional content of foods [a] | **.622** | .004 | -.036 | .077 |
| Nutrition [c] | **.457** | -.126 | -.106 | -.120 |
| **Barriers to healthy eating [d]** | | | | |
| Too much effort | .108 | **.726** | -.063 | .178 |
| Don't want to change my eating habits | .081 | **.703** | .190 | -.018 |
| Must please family | .032 | **.659** | .098 | -.139 |
| Work | -.034 | **.638** | .212 | .005 |
| Nutrition is too confusing to me | .181 | **.621** | .068 | -.065 |
| Low-fat foods are unappetizing | -.202 | **.500** | .031 | .139 |
| **Emotionally influenced eating [e]** | | | | |
| When I am depressed, I eat more junk food | -.025 | .096 | **.807** | .053 |

BMI (n=83), while more than one-quarter were overweight (n=55) and the remaining 33% were obese (n=68). Nearly two-thirds of the sample had modest or severe weight gain; over a third (n=74, 35.9%) gained 7 kg or more. Non-Hispanic White women had lower BMIs (26±0.9) than Hispanics (29±0.8 $p<0.05$). Those who had completed some college or were college graduates had lower BMIs (25±1.0) than those who did not complete (28±0.7, ns), or graduated (29±0.9, $p<0.05$) high school; this was not affected by age or lactation score. Weight retention at one year postpartum did not differ according to demographics or BMI.

The average lactation score for the study population over 12 months postpartum was 4.0±0.11, as the majority of women (61.2%) did not lactate during any of the time points assessed (no lactation = score of three; higher score represents more lactation). Non-Hispanic Whites had a higher mean lactation score (4.2±.12) than non-Hispanic Blacks (3.5±.14, $p<0.05$) and Hispanics (3.3±.13, $p<0.05$) at 12 months. Lactation score did not differ by other demographic groups, but was negatively correlated to BMI at 1.5 ($r$= -0.21, $P<0.05$), 6 ($r$= -0.21, $p<0.05$) and 12 months ($r$= -0.21, $p<0.05$). Thus, mothers who breastfed more often had lower BMIs.

**Weight Status, Demographics, and Attitude Subscales**

Mean scores on the instrument subscales at 1.5, 6 and 12 months are illustrated in Figure 2.1. With a mean value of 3.7±.08 at 1.5 months, healthy eating did not change over time within the entire study population. However, there was a significant association

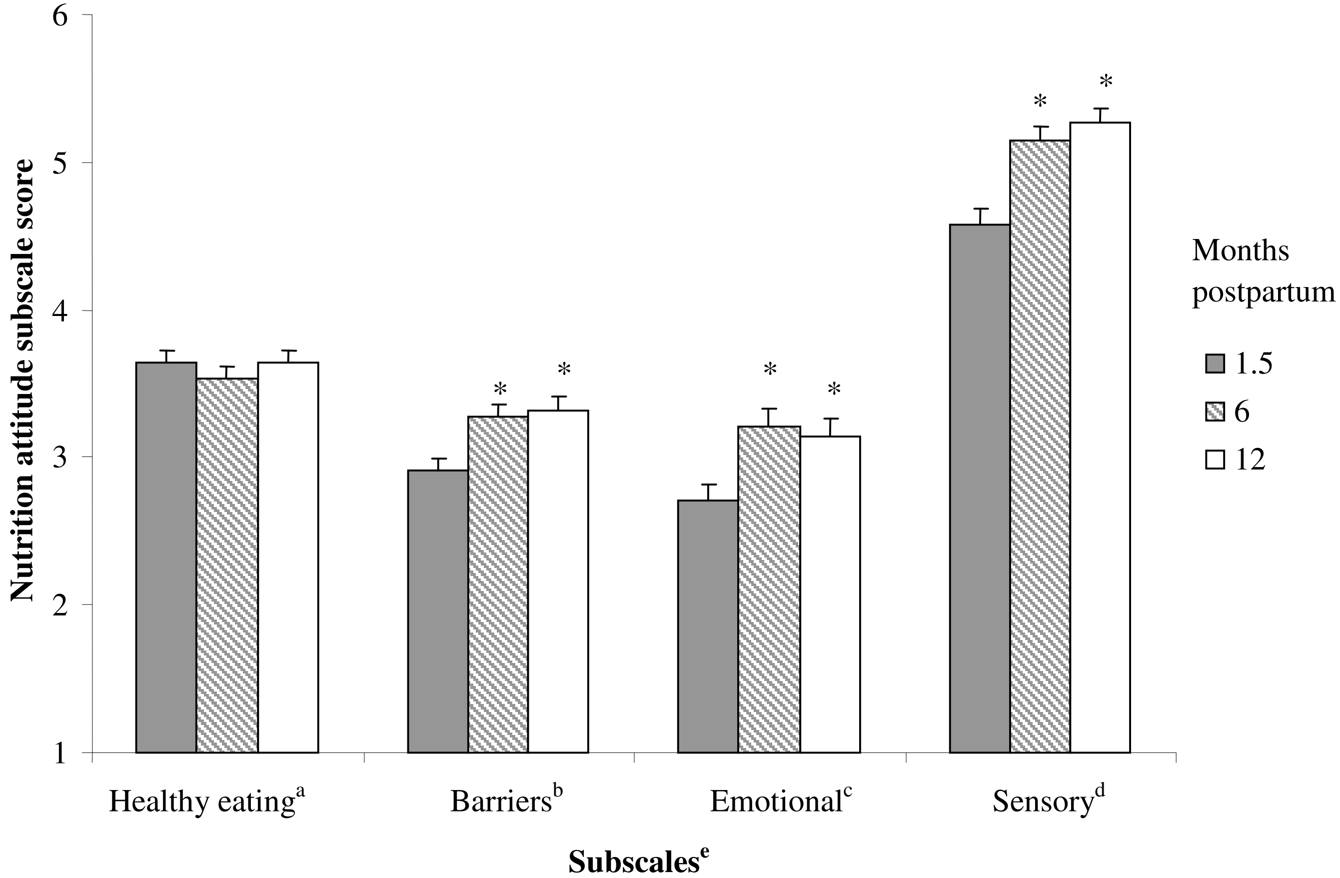



**Figure 2.1**. Mean (±SEM) values of nutrition attitude subscale scores[a] during the first year postpartum (n=206)

*Significantly different from 1.5 months postpartum ($p < 0.05$).

[a]Choosing low-fat foods, using labels, concerned with nutritional content of foods.

[b]Obstacles which prevent the adoption/maintenance of a liet.

[c]Emotional states influenced eating behavior.

[d]Sensory/physiological motivators for eating, such as taste, hunger, and cravings.

[e]Higher scores (range of 1 = lowest to 7 = highest) indicat greater contribution of subscale as a greater motivator for eating.

with age ($F=4.9$, $p<0.05$), as women >24 yrs had greater scores at 1.5 months than the ≤20 age group (4.0±.19 vs. 3.4±.12, $p<0.05$), and both ≤20 yrs and 21 – 24 yrs groups at 6 months (3.9±.19 vs. 3.2±.14, $p<0.05$, and 3.9±.19 vs. 3.6±.11, $p<0.05$, respectively). Similarly, those with the most education had scores that were higher than all other groups at every measurement interval ($F=12.6$, $p<0.05$). Lactation score was positively correlated with healthy eating at 1.5 ($r=.22$, $p<0.05$), 6 ($r=.18$, $p<0.05$), and 12 months ($r=.15$, $p<0.05$). Healthy eating did not differ according to BMI at one year postpartum (Table 2.3).

The barriers to healthy eating subscale score was at its lowest point during early postpartum, with an average of 2.9±.08 at 1.5 months postpartum for the entire sample; this was significantly lower when compared to 6 (3.3±.08, $p<0.05$) and 12 months (3.3±.09, $p<0.05$). While there was no effect of any of the demographic variables, lactation score was negatively correlated with barriers at all time points ($r=-.14$, $p<0.05$, $r=-.21$, $p<0.05$, and $r=-.14$, $p<0.05$, respectively). Women who were obese at one year had higher barrier subscale averages than normal and overweight subjects at 1.5 (3.3±.16 vs. 2.9±.12 and 2.5±.13, respectively) and 6 months (3.6±.14 vs. 3.2±.12 and 3.1±.16, respectively), and greater than overweight participants only at 12 months (3.5±.16 vs. 3.0±.19) ($F=6.1$, $p<0.05$). Controlling for lactation score eliminated the statistical significance between normal and obese women at 1.5 and 6 months.

The emotional eating subscale mean was also at its lowest value in early postpartum (2.6±.11), and increased at 6 (3.2±.12, $p<0.05$) and 12 months (3.1±.12, $p<0.05$). Age

**Table 2.3.** Nutrition attitudes over postpartum according to BMI groups[a]

| | Months postpartum | | |
|---|---|---|---|
| **Nutrition attitude subscales** | **1.5** | **6** | **12** |
| | *mean*[b]±*SD*[c] | | |
| **Healthy eating** | | | |
| Normal (<=24.9) | 3.6±1.1 | 3.5±1.2 | 3.4±1.0 |
| Overweight (25 - 29.9) | 3.7±1.2 | 3.6±1.2 | 3.6±1.3 |
| Obese (>=30) | 3.7±1.1 | 3.6±1.3 | 3.6±1.2 |
| **Barriers** | | | |
| Normal (<=24.9) | 2.9±1.1 [y] | 3.2±1.1 [y] | 3.4±1.2 |
| Overweight (25 - 29.9) | 2.5±1.0 [y] | 3.1±1.2 [y] | 3.0±1.4 [y] |
| Obese (>=30) | 3.3±1.3 [z] | 3.6±1.2 [z] | 3.5±1.3 [z] |

Table 2.3, cont.

| | | | |
|---|---|---|---|
| **Emotional** | | | |
| Normal (<=24.9) | 2.6±1.5 | 3.0±1.6 | 2.9±1.5 $^{y}$ |
| Overweight (25 - 29.9) | 2.4±1.4 $^{y}$ | 3.2±1.7 | 2.8±1.6 $^{y}$ |
| Obese (>=30) | 3.0±1.7 $^{z}$ | 3.5±1.9 | 3.7±2.1 $^{z}$ |
| **Sensory** | | | |
| Normal (<=24.9) | 4.9±1.4 $^{y}$ | 5.5±1.3 $^{y}$ | 5.7±1.1 $^{y}$ |
| Overweight (25 - 29.9) | 4.1±1.5 $^{z}$ | 4.7±1.4 $^{z}$ | 4.9±1.3 $^{z}$ |
| Obese (>=30) | 4.5±1.7 | 5.1±1.4 | 5.1±1.5 $^{z}$ |

[a]Normal: n=83; Overweight: n=55; Obese: n=68.

[b]Values represent the relative influence of a subscale on a mother's motivation to eat (range of 1 = lowest to 7 = highest).

[c]SD=standard deviation

[xyz] Within subscales within columns, means with different superscripts are significantly different.

had a significant effect on emotional eating (F=5.5, $p<0.05$), as mean scores for women > 24 years were greater than all other groups at 1.5 months, and higher than the youngest group at one year postpartum. At 1.5 months, weight status also significantly affected emotional eating (F=4.3, $p<0.05$), as obese individuals had higher average subscale scores than overweight women (3.0±.21 vs. 2.4±.18, $p<0.05$), and greater than both normal and overweight subjects at 12 months (3.7±.26 vs. 2.8±.16 and 2.8±.21, respectively, $p<0.05$). This relationship was not affected by controlling for demographic variables or lactation.

The sensory/physiological subscale was higher than other subscales at each time point ($p<0.05$) and increased from baseline (4.6±.11) at 6 (5.1±.09) and 12 months (5.3±.09) ($p<0.05$). Within the subscale itself, normal weight women felt that the influences of hunger/satiety were more important motivations for eating than overweight/obese women at 12 months. Women with a parity of three had lower mean values on the sensory/physiological subscale than single-infant women, and lower than those with a parity of two at 6 months only (F=6.6, $p<0.05$). Lactation was positively related to the sensory/physiological subscale only in early postpartum ($r=.23$, $p<0.05$). Women with a healthful BMI at one year postpartum had higher sensory subscale scores than overweight women at both 1.5 and 6 months postpartum, and greater than both overweight and obese women at 12 months (Table 2.3); controlling for parity, education, and lactation score had no influence.

**Nutrition Attitude Survey**

Mothers agreed least with the question "Was boredom a motivation for eating?" Scores for this item increased significantly as postpartum progressed. Similarly, the percentage of subjects who reported cost (42.4% vs. 61%, $p<0.05$) and time as (50% vs. 60.4%, $p<0.05$) barriers to healthy eating rose from 1.5 to 6 months postpartum, respectively. Cost was a greater barrier to the obese than overweight women after 1 year (4.3±.21 vs. 3.5±.29, $p<0.05$, respectively). Over three-fourths of the women (77.6%) believed that "My family would help me if I chose to lose weight" during early postpartum; this belief declined (67.5%, $p<0.05$) at 6 months. The same pattern was observed with the statement "I am confident that I will return to my prepregnancy weight" (84.5% agreed at 1.5 months vs. 73.8% at 6 months, $p<0.05$). Normal weight women significantly ($p<0.05$) had higher scores for this item than the obese at all time points.

## DISCUSSION

Low-income women who were obese at one year postpartum appeared to be emotional eaters, in comparison to those with normal weights. Obese women reported eating more when they were depressed, stressed/anxious, or angry, regardless of age, parity, ethnicity, or lactation score. Other studies measuring emotional eating in postpartum are lacking, but in low SES adult women Elfhag et al. (2003) found difficulties in coping with stressors and irregular meal patterns. However, this study did not differentiate according to body weights. Other research also has shown a negative association between emotional eating and healthful weight status (Geliebter and Aversa 2003, Macht 1999, Fassino et al. 2003, Popkess-Vawter et al. 2000, Cox et al. 1998). For example, Geliebter and Aversa (2003) observed that normal or underweight subjects ate less than overweight adult men and women with negative emotions (sad, bored, angry, frustrated, tired, depressed, frightened, under pressure). Additionally, Macht (1999) found a positive correlation between weight status and anger, fear, and sadness. The association to weight status is not surprising as emotional eaters often overindulge with energy-dense, nutrient-poor foods (Macht 1999). Collectively, these studies support the present findings that obese subjects ate more in response to emotional cues.

In contrast, women who had healthful weights at one year postpartum were more concerned with sensory/physiological aspects of foods, such as taste, hunger/satiety, and cravings, than those who were overweight or obese. Taste is believed to be the most important motivator for eating (Cox et al. 1999, Snoek et al. 2004, Glanz et al. 1998) and is a predominant factor influencing women, as opposed to men (Glanz et al. 1998). The relationship of taste to eating may be particularly true during lactation, when an enhanced uptake of prolactin in the brain (Grattan et al. 2001) increases appetite, making the taste sense more acute. But, lactation had no discernable influence in this study

Increased taste sensitivity, as determined by a positive response to the bitter tasting 6-*n*-propylthiouracil (PROP), has been observed in women with lower BMIs (Tepper et al. 2002) and in adults with a diminished preference for sweet and high-fat foods (Duffy and Bartoshuk 2000). Although PROP sensitivity was not measured in the present study, these observations support the finding that taste was the strongest motivator for eating in women with healthful BMIs.

Normal weight women also indicated that hunger had a greater influence on eating than did the overweight/obese. In contrast, Provencher et al (2003) found that obese subjects ate more in response to hunger than the non-obese; the quantity that subjects from the present study ate in response to hunger is uncertain. Others have not seen an association between hunger and weight status in women (Boschi et al. 2001) or men and women (Macht 1999), but these studies were not conducted in postpartum.

Scores of healthy eating subscales in this study did not vary over the first year following childbirth. This lack of change was unexpected, as one might anticipate women to become more health conscious as they became accustomed to their new role as mothers. However, Devine et al. (2000) also did not observe changes in attitudes towards diet, exercise, and weight from prepregnancy to 8 months postpartum in well educated, Non-Hispanic white women. Thus, health may not be a focus for new mothers, regardless of SES. Presumably, this lack of emphasis on health may be due to competing demands of time, physiological changes, altered finances, or restructuring of social life.

Women who were younger and less educated felt that a healthful diet was less relevant as compared to older, more educated participants. The interaction of age, education, and healthful attitudes towards nutrition has been identified by a number of investigators (Glanz et al. 1998, Stafleu et al. 1996, McArthur et al. 2001, Glanz et al. 1993, Satia et al. 2001). For example, Satia and her colleagues (2001) found that personal health related to dietary behavior was less important in middle aged versus older non-Hispanic Whites. In a larger national study of U.S. adults, Glanz et al. (1993) also documented that nutrition was of greater interest as age increased.

Barriers to healthy eating increased significantly as postpartum progressed, and were quite prevalent in this sample of tri-ethnic, obese women. To our knowledge, the present study is the first to measure this characteristic in the first year postpartum in low-income women. However, barriers to healthy eating have been documented by others (Chatterjee et al. 2005, Kieffer et al. 2004, James 2004, Eikenberry and Smith 2004, Palmeri et al. 1998) in U.S. minority and low-income populations. Common barriers included time (Chatterjee et al. 2005, Kieffer et al. 2004, James 2004, Eikenberry and Smith 2004, Palmeri et al. 1998), cost (Kieffer et al. 2004, James 2004, Eikenberry and Smith 2004, Palmeri et al. 1998), lack of understanding or information of nutrition (knowledge) (Kieffer et al. 2004, James 2004, Eikenberry and Smith 2004), taste and preferences of 'healthy' foods versus high-fat foods (Chatterjee et al. 2005, Kieffer et al. 2004, Eikenberry and Smith 2004, Palmeri et al. 1998). In the present study, cost, time and a lack of understanding of nutrition also were significant barriers to healthy eating, and their influences became more pronounced from early to mid and late postpartum.

The instrument developed for this research appears to be a reliable measure of nutrition attitudes in this population of tri-ethnic, low-income new mothers. As measured by Cronbach's alpha, three of the four subscales (healthy eating, barriers to healthy eating, and emotional eating) had good internal consistency reliability ($\alpha > .70$) (Nunnally 1978). The sensory/physiological subscale was slightly lower ($\alpha = .65$), presumably due to the small number of items that were significant in the factor loading. Nonetheless, this construct was the most important for the new mothers in this study. In 1989, Anderson and Shepherd (1989) developed an instrument that identified attitudes and beliefs pertaining to healthful food choices in pregnant and post-natal women. Their population differed in that they were British, predominately married, and of mixed social class. In their study, the majority of women indicated positive intentions towards healthy eating. Although behavioral intent in the present study, subjects did not appear to be motivated to eat healthy, as indicated by the low subscale scores throughout the first year postpartum.

Other attitudinal studies related to nutrition in postpartum have focused on eating disorder pathologies in upper (Baker et al. 1999) and mixed income (Carter et al. 2000, Stein and Fairburn 1006) populations. In high-income women, Baker and colleagues (1999) found that attitudes related to unhealthy eating practices increased from pregnancy to four months postpartum. In the mixed income population, Stein and co-workers (1996) observed that attitudes related to eating disorders fluctuated greatly during the first

6 months postpartum, with no differences between social classes. Carter et al. (2000) disclosed that attitudes related to body shape and pathological avoidance of fattening foods increased from 4 to 14 months postpartum, with no influence of income. In the present study of low-income women, attitudes towards healthy eating remained unchanged in postpartum.

One limitation of this study was the self-report of prepregnancy weights. It is desirable to use measured body weights, but self-reported weights have been used in other previous investigations of pregnant and postpartum populations (Lederman et al. 2002, Kac et al. 2004, Linne and Rossner 2003, Gunderson et al. 2001). Studies have found that self-reported weights of adults corresponded closely to actual weights (Gunderson et al. 2001, Stewart et al. 1987).

## CONCLUSIONS

Women who were obese at one year postpartum were more likely than normal and over weight subjects to eat in response to emotional cues. These results are consistent with other studies measuring emotional eating and weight status in non-postpartum, adult populations. Early identification of women who eat in response to emotional cues could be part of an effective strategy to minimize weight retention during postpartum.

In the overweight and obese, sensory aspects were less important for eating than those with healthful BMIs. It is plausible that strong emotional influences in postpartum may have mitigated the influence of sensory aspects of eating in this cohort. Learning skills to cope with emotional stressors after childbirth could permit new mothers to respond more to internal physiological cues that impact eating.

The increase in barriers to healthy eating as postpartum progressed is not surprising as lifestyle changes so abruptly at this time. Health professionals could emphasize potential changes and difficulties often faced in postpartum and identify techniques to overcome these obstacles to healthy eating.

# Chapter 3: Greater Nutrition Knowledge is Associated with Lower 1-year Postpartum Weight Retention in Low-income Women


## ABSTRACT

**Objective :** To determine the degree of nutrition knowledge and use of nutrition information sources in low-socioeconomic status women in early and late postpartum and to discern their influence on weight retention at 1 year postpartum.

**Design:** Nutrition knowledge was assessed 0-1 days and 12 months postpartum. Height/weight measurements were taken to calculate body mass index. Scores were compared to 12-month postpartum weight retention and demographic variables.

**Subjects:** 291 Caucasian (28.6%), African American (30.7%), and Hispanic (40.7%) low-income women (mean age 22.5 years). Eligibility included: good health at delivery; age ≥18; parity ≤ 3; ability to speak/read English; healthy child at birth; low-income (≤ 185% Federal poverty guideline).

**Statistical Analyses:** $\chi^2$ test detected differences in demographic/weight groups. Paired t-test determined changes between 0 and 12-month knowledge. McNemar's test identified changes in dichotomous variables. Multivariate analyses, followed by univariate analyses of covariance on 12-month scores.

**Results:** Women with < 5% weight retention had greater knowledge at 0 (53% vs.49%, P<.05) and 12 months (55% vs. 51%, $p$<0.05) than those with ≥ 5%. Caucasians scored higher than African Americans and Hispanics. Women who lactated ≥ 6 months had

more knowledge than those who lactated < 6 months. Higher scores were observed for users of the Internet, books/magazines for information.

**Conclusions:** Assessment of nutrition knowledge in early postpartum can identify women at-risk for significant weight retention. Breastfeeding was associated with knowledge and lower weight retention. Internet and printed materials were effective resources of nutrition education. Curriculum to promote weight loss should focus on the fat and energy content of foods.

## INTRODUCTION

In the United States (US) the majority of adults aged ≥ 20 are considered to be overweight (65%) (body mass index [BMI, kg/m²] = 25 – 30) or obese (31%) (BMI ≥30) (NHANES 2004, Hedley et al. 2004). This incidence of obesity is greater for women than men (34% *vs.* 28%), and increased risk is associated with low socio-economic/minority status (Hedley et al. et al. 2004, Rooney et al. 2002, Kristal et al. 1999) and childbearing age (Hedley et al. 2004, Healthy People 2010, Rooney et al. 2002). In some women, weight retained from pregnancy appears to contribute to overweight/obesity later in life (Kac et al. 2004, Linne et al. 2004, Lederman et al. 2002, Gunderson et al. 2000). For example, a 2004 study of 405 Brazilian women found that 35% of each kilogram (kg) gained during pregnancy was retained at 9 months postpartum (Kac et al. 2004). Linne et al. (2004) reported that retained weight was still present 15 years following pregnancy. This excess weight may have adverse long-term, health effects as it is wel established that obesity is linked to hypertension, diabetes, cardiovascular disease (CVD), and arthritis (Visscher et al. 2004, Wilson et al. 2002, Brown et al. et al. 2000).

Why some women fail to return to prepregnancy weight is still not fully understood. It is well known that factors such as excessive gestational weight gain (Linne et al. 2004, Olson et al. 2004, Walker et al. 2004), depression (Gracious et al. 2005, Walker et al. 2004), high energy intake following delivery (Walker et al. 2004), lactation status (Kac et al. 2004, Adair et al. 2004, Kugyelka et al. 2004), maternal insulin concentrations during pregnancy (Scholl et al. 2002), and age (Valeggia et al. 2003) have some influence on postpartum weight retention. However, the impact of nutrition knowledge has not yet been fully considered.

A positive relationship with nutrition knowledge and weight loss has been suggested in a previous study of *non-postpartum* overweight/obese low-income, tri-ethnic women with young children (Klohe-Lehman et al. 2006). Klohe-Lehman et al. (2006) reported that participants who lost more weight had greater nutrition knowledge at the beginning and end of an 8-week weight and diet intervention. Similar findings were described by Domel and colleagues in weight control programs for African Americans (Domel et al. 1992a) and Hispanics (Domel et al. 1992b). After an 11-week nutrition education and behavioral modification program, groups from both studies by Domel had higher nutrition knowledge and greater weight loss when compared to controls.

The association of nutrition knowledge and weight reduction also has been seen in adult men and women (Jalil et al. 2004, Menza et al. 2004). Jalil et al. (2004) administered a 12- week program to 60 obese adults that included dietary instructions, counseling and physical activity. The expected increase in nutrition knowledge corresponded with a 6% weight loss. In a year-long weight control program of nutrition and exercise, Menza et al. (2004) observed that 20 overweight and obese had increased nutrition knowledge and lost more weight than controls, but direct comparisons of knowledge to weight were not reported.

Studies utilizing only *postpartum* women also indicate that nutrition knowledge may be beneficial for weight reduction in well-educated, Non-Hispanic White adults (Leermaker et al. 1998, O'Toole et al. 2003). Decreases in weight retention from 12

(O'Toole et al. 2003) to 18 months (Leermaker 1998) after childbirth were observed in women who were exposed to a diet and behavioral modification intervention. This suggests that knowledge delivered during the program could promote weight loss; however, nutrition knowledge was not measured specifically in the study.

The purpose of this study is to determine the degree of nutrition knowledge in low-socioeconomic status women in early and late postpartum and to discern its influence on weight retention at 1 year postpartum. In addition, an instrument for measuring nutrition knowledge was developed and validated.

## METHODS

### Study Design

A test of general nutrition knowledge was developed and validated in a sample of 151 low-income women at 1 day following childbirth. The validated instrument was then administered to a test sample of 140 women during the same time period. In addition, a demographic questionnaire was completed. Test subjects visited a clinic site at 1.5, 6, and 12 months postpartum and measured for body weight; height was recorded at 1.5 months. The knowledge test was administered again at the last visit.

### Subjects

Subjects consisted of a convenience sample of the first 291 subjects derived from a larger study sample (Walker et al. 2004). Information obtained included demographics (age, education, parity, marital status, income, and ethnicity), prepregnancy weight, and gestational weight gain. Eligibility included: good health at delivery; ≥18 years of age; parity of ≤ 3; ability to speak and read English; a healthy child at birth without complications; low-income (≤ 185% the Federal guideline for poverty); and self-identified as Non-Hispanic White, Latin American, or African American. All subjects were eligible for enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Women were informed of the nature of the study, and signed written consent of their participation. Participants signed consent forms approved by the Institutional Review Board at The University of Texas at Austin.

**Weight and Lactation Status**

Postpartum weights were recorded to the nearest 0.1 kilogram (kg) at 1.5, 6, and 12 months using a calibrated digital scale (Fairbanks Portable Digital Scale, Model No. HS100, Kansas City, MO). Height was measured at 1.5 months to the nearest 0.1 centimeter using a stadiometer (Perspective Enterprises, Portage, MI). Body mass index (BMI) was computed as $kg/m^2$. The distribution of BMI categories based on the Institute of Medicine (IOM) (1992) guidelines was: low (BMI<19.8) = 8.6%, normal (BMI 19.8-26.0) = 54.3%, overweight (BMI 26.1-29.0) = 12.1%, obese (BMI>29.0) = 23.6%. Postpartum weight retention was calculated as $(w_x - w_0/w_0)$ x 100, where $w_x$ represents postpartum weight (at 1.5, 3, 6, and 12 months) and $w_0$ represents prepregnancy weight. Prepregnancy weight was self-reported and gestational weight gain was obtained from hospital records. Lactation status (1= not lactating/bottle feeding only, 2 = combination breast/bottle feeding and 3 = breastfeeding only) was assessed at 1.5, 6, and 12 months postpartum. A lactation score was calculated by adding values from each time point with a range of three (lowest: did not lactate at any measured time point) to nine (highest: breastfed exclusively throughout).

**Questionnaire**

The instrument developed for this study was designed to ascertain knowledge of general nutrition. Procedures for development were based primarily on the recommendations of Parmenter and Wardle (2000). Test questions were derived from the literature and topics covered in media sources, and included 50 multiple-choice and true/false.  To establish face validity, this initial version was reviewed by a group of nutrition professors, graduate students and registered dietitians.  Items were reworded or omitted as necessary.  This version was pilot tested in 151 low-income, tri-ethnic new mothers.  Item exclusion criteria consisted of: ≤ 20% or ≥80% correct response rate, an item-to-total correlation ≤ 0.2, and a significant reduction of the Chronbach's alpha below 0.7 (Parmenter and Wardle et al. 2000).  Based on these guidelines and recommendations from experts, 25 of the original 50 items were discarded.  This 25-item questionnaire was then reformatted and reviewed by experts for content validity. Discriminate validity was established by administering the test to a sample of nutrition graduate students and registered dietitians (n = 17) and comparing scores to a sample of 125 undergraduates.  Construct validity was confirmed, as the sample of nutrition graduate students scored significantly higher (94.9% *vs.* 56.1%, $P<0.001$).  Test-retest reliability was performed in a sample of 100 undergraduate students and measured via Pearson's correlation coefficient $r$ (0.79).   An exploratory factor analysis was performed to determine if any latent factors were present.  As anticipated, there were no discernable factor loadings, supporting the concept that the instrument measured general nutrition knowledge.  Internal consistency reliability (Cronbach's alpha = 0.89) was above the established acceptable level of 0.7 (DeVellis 1991, Nunnaly 1978).  Tests were scored by calculating the percentage of correct responses.

## Statistical Analysis

The Statistical Package for Social Sciences (version 11.5, SPSS, Chicago, Ill) was used for data analysis. Entered data were checked for accuracy and normality. Descriptive statistics, such as means, frequencies, distribution percentages, and ranges, were computed for demographic and weight variables, as well as nutrition knowledge total scores and individual test items. The $\chi^2$ statistic detected differences in the distributions of demographic, lactation, and weight groups. The paired-samples t-test was used to determine differences between baseline and 12-month nutrition knowledge. The McNemar's test identified changes in responses of dichotomously coded variables. A multivariate analysis of variance was employed to examine changes in knowledge over time between demographic, lactation, and weight retention categories. Multivariate analyses were followed by univariate analyses of covariance on 12-month nutrition knowledge. Covariates were included to adjust for preexisting differences among the demographic and lactation variables. Statistical significance was set at $P<.05$.

## RESULTS

### Participant Characteristics

The profile of the subjects for both the validation and test samples (Table 3.1) show no significant differences according to demographic variables. The average age for all subjects (N=291) was 22.1±0.22 (mean±SEM) years, ranging from 18 to 38. For both samples, Hispanics represented the largest ethnic group and women had a parity of 1 – 2. More than half had no/partial high school or were high school graduates. Over 60% were not married or living with a partner. Nearly two-thirds of the sample (62.1%) lactated for 0 – 1.5 months, while less than one-fifth (18.6%) lactated ≥ 6 months.

### Weight and Lactation Status

The average prepregnancy BMI ($kg/m^2$) of the test sample was 25.8±0.49 (range of 16.4 to 45.2). Subjects gained an average of 15.6±0.6 kg (range of 1.8 to 38.6 kg) during pregnancy, with 20.7% below, 42.1% within, and 37.1% above IOM recommendations. Obese women were more likely to have gained the recommended amount of weight (87.9%, $P$<.001). At 0 months postpartum, mean BMI was 30.4±0.5 (range of 20.7 to 48.5). This value decreased at 1.5 months postpartum to 28.2±0.5 (range of 18.9 to 46.9, $P$<.001) and did not change by the first year postpartum.
The average 12-month BMI was 28.3±0.6 (range of 17.7 to 47.6). This value represents a mean weight increase of +6.5±0.7 kg (range of -14.0 to 42.4 kg), which is an increase of +9.8% from prepregnancy weight ($P$<.001). Nearly two-thirds (n=88) of the sample were ≥ 5% heavier than their prepregnancy weight (mean weight gain of 11.0±0.7

**Table 3.1.** Subject profile

| | Validation sample[a] | | Test sample[b] | |
|---|---|---|---|---|
| **Characteristic** | **n** | **Percentage** | **n** | **Percentage** |
| **Age (y)** | | | | |
| 18 - 20 | 67 | 44.4 | 51 | 36.4 |
| 21 – 24 | 57 | 37.7 | 56 | 40.0 |
| > 24 | 27[*] | 17.9 | 33[d] | 23.6 |
| **Ethnicity** | | | | |
| Caucasian | 47 | 31.1 | 40 | 28.6 |
| African American | 29[*] | 19.2 | 43 | 30.7 |
| Hispanic | 75 | 49.7 | 57 | 40.7 |
| **Parity** | | | | |
| 1 | 55 | 36.4 | 60[*] | 42.9 |
| 2 | 57 | 37.7 | 46 | 32.9 |
| 3 | 39 | 25.8 | 34 | 24.3 |
| **Education** | | | | |
| No/partial high school | 67 | 44.4 | 52 | 37.1 |
| High school graduate | 51 | 33.8 | 60 | 42.9 |
| Partial/college graduate | 31[*] | 20.5 | 28[*] | 20.0 |
| **Marital status** | | | | |
| Single, not living with partner | 105[*] | 69.5 | 85[*] | 60.7 |
| Married, living with partner | 46 | 30.5 | 54 | 38.6 |

Table 3.1, cont.

| | | | | |
|---|---|---|---|---|
| **Lactation** | | | | |
| 0 to 1.5 months | _ | _ | 87 | 62.1 |
| 1.5 to 6 months | _ | _ | 27 | 19.3 |
| ≥6 months | _ | _ | 26 | 18.6 |

[a]n=151.

[b]n=140.

*$p$<.05 comparing characteristic subgroups within individual samples based on chi-square test.

kg, range of 2.9 to 25.8 kg). Subjects of this subgroup tended to be younger (43.2% between 18 – 20 yrs) and less educated (40.9% with no/partial high school) ($P<.05$) than those who were <5% their prepregnancy weight at one year postpartum (mean weight loss of -1.5±0.6kg, range of -14.0 to 3.5kg). They were also more likely to have gained more weight during pregnancy than IOM recommendations (50.0%, $P<.001$).

**Nutrition Information Sources**

The most common source of nutrition information used by participants at the hospital visit was a physician (55.7%), followed by books/magazines (55.0%), family (45.7%), friends (36.4%), and television (22.9%). Sources used the least were the food labels (15.0%) and the Internet (14.3%). At one year, the usage of all information sources dropped significantly, as books/magazines became the most relied upon (40.0%, $P<.001$), succeeded by family (32.9%, $P<.001$), friends (29.3%, $P<.001$). At any time point, a greater percentage of the most educated women (40%) used the Internet as a source of nutrition information (*vs.* 35% no/partial high school, 25% high school graduates, $P<.05$). Women who lactated 0 – 1.5 months postpartum (44%) were less likely to obtain nutrition information from a physician as compared to those who lactated for 1.5 – 6 months or ≥6 months (78%, and 73%, respectively, $P<.01$). This was also true for the use of books and magazines (45%, 70%, and 73%, respectively, $P<.01$). Women who lactated ≥6 months (31%) used food labels more often than those who lactated 1.5 – 6 months (15%), or for 0 – 1.5 months (10%, $P<.05$).

## Nutrition Knowledge from 0 to 12 Months Postpartum

On the first day following childbirth, the mean knowledge score for the test sample was 53.1±.91% (range of 24.0 to 76.0%). This score did not change significantly over the first postpartum year (54.8±1.0%, range of 28.0% to 84.0%). Selected individual items on the test which significantly increased or decreased are listed in Table 3.2. Figure 3.1 illustrates that Non-Hispanic Whites had higher knowledge scores than both African Americans and Hispanics at both 0 and 12 months ($P<.001$). However, using baseline scores as a covariate negated the significant difference at 12 months. Younger mothers had lower scores (52.6±1.2%) than the older subjects (57.3±1.5%) at 12 months only ($P<.05$). Education had a positive influence on knowledge, as the most educated group had greater scores than both of the lesser education categories at 0 and 12 months ($P<.01$).

Figure 3.2 shows nutrition knowledge scores as compared by lactation groups. Women who lactated 0 – 1.5 months postpartum had lower 12-month knowledge scores than the other lactation groups ($P<.05$), controlling for other covariates. Among the individual test items, those who lactated ≥ 1.5 months were more likely to correctly answer items pertaining to the knowledge that foods labeled as low fat do not always mean fewer calories, margarine contains trans-fatty acids, and high levels of homocysteine are associated with heart disease ($\chi^2$ values ranging from 6.3 to 13.0, all significant at $P<.05$).

**Table 3.2.** Sample test items and responses (%) at 0 and 12 months postpartum(n =140).

| Test item[a] | Postpartum months 0 | 12 |
|---|---|---|
| Which food contains the greatest amount of fiber per cup? | | |
| a. brownies | 4.3 | 0 |
| b. corn flakes | 40.0 | 40.7 |
| c. iceberg lettuce | 5.0 | 2.9 |
| d. *kidney beans* | 37.1 | 44.3** |
| e. pasta | 13.6 | 12.1 |
| Which of the following has the least amount of high quality protein? | | |
| a. *corn* | 37.9 | 54.3*** |
| b. egg | 7.9 | 7.9 |
| c. milk | 9.3 | 7.9 |
| d. tofu | 34.3 | 22.1 |
| e. wheat | 10.7 | 7.9 |
| Which of the following foods has the highest amount of fat? | | |
| a. bagel | 7.1 | 6.4 |
| b. *blueberry muffin* | 30.7 | 39.3** |
| c. saltines | 10.0 | 8.6 |
| d. pretzels | 12.9 | 7.1 |
| e. all the same | 39.3 | 38.6 |
| Not enough _________ in the diet has been linked to birth defects involving the brain and spine (spina bifida). | | |
| a. calcium | 14.3 | 10.7 |
| b. *folic acid* | 54.3 | 60.7** |
| c. iron | 23.6 | 22.9 |
| d. vitamin A | 4.3 | 2.9 |
| e. vitamin C | 3.6 | 2.9 |
| Phytochemicals can be found in which of the following? | | |
| a. dairy products | 7.1 | 3.8 |
| b. eggs | 5.7 | 5.8 |
| c. *fruits and vegetables* | 27.1 | 42.3* |
| d. meats | 9.3 | 11.5 |
| e. all of the above | 50.7 | 36.5 |

Table 3.2, cont.

| | | |
|---|---|---|
| A pregnant woman requires more calories than a woman who is breastfeeding. | | |
| *False* | 87.9 | 72.9* |
| True | 12.1 | 27.1 |
| Watermelon is an excellent source of vitamin C. | | |
| *False* | 20.7 | 32.1* |
| True | 79.3 | 67.9 |

[a]Correct responses are italicized.
*$p$<0.05
**$p$<0.01
***$p$<0.001

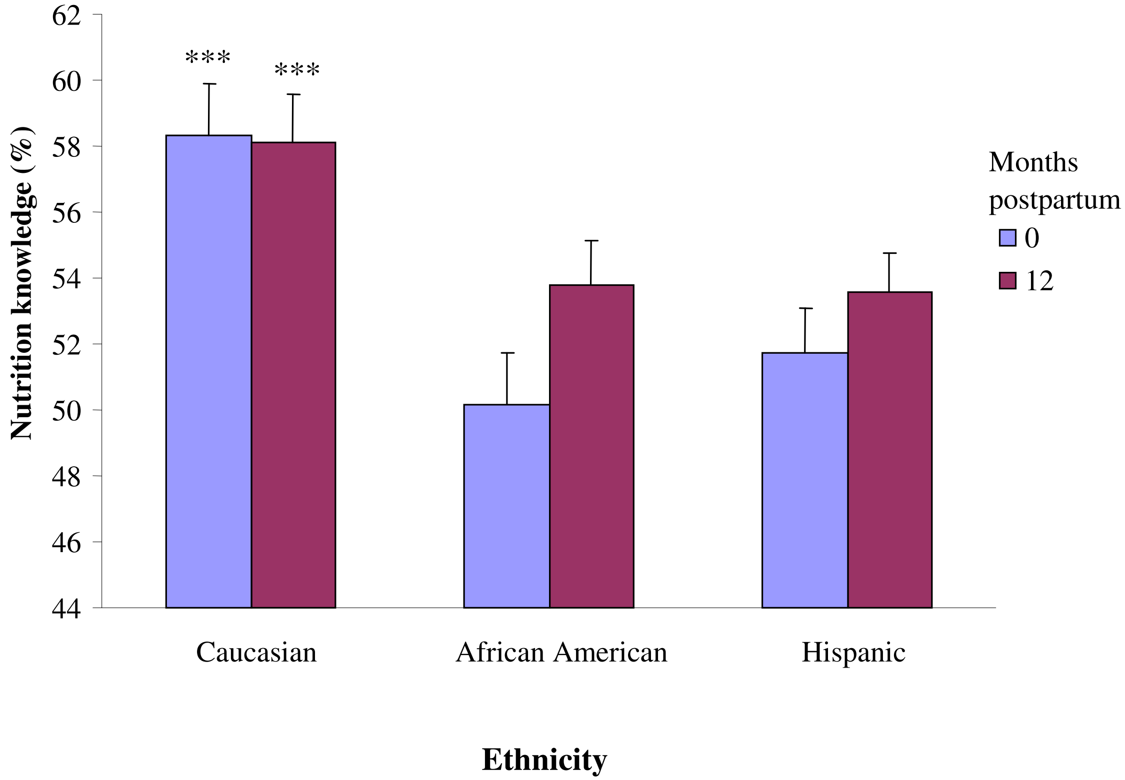



**Figure 3.1**. Nutrition knowledge at 0 and 12 months by ethnicity.

*** Significantly different than African American and Hispanic (*p*<0.001).

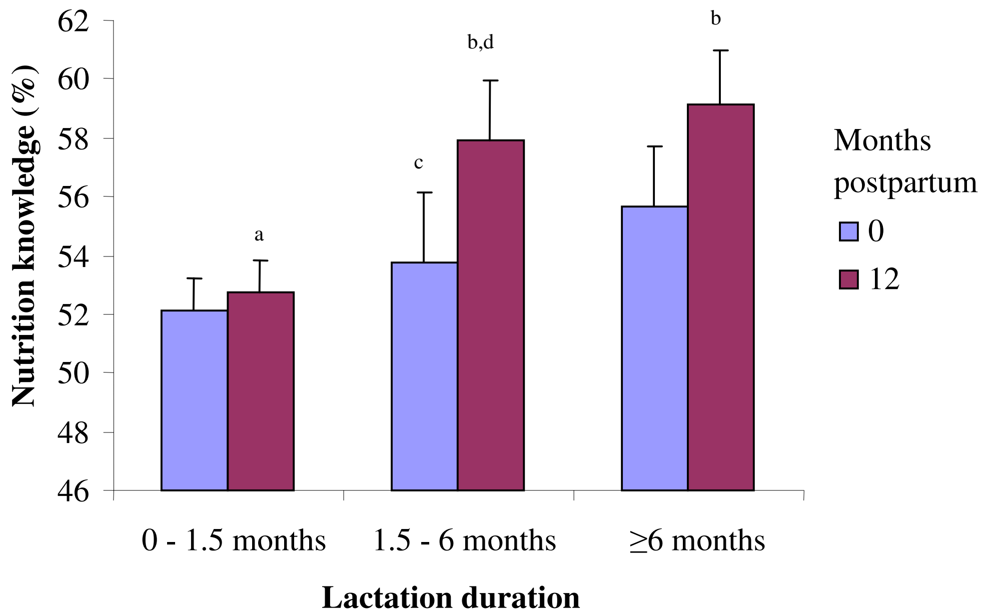



**Figure 3.2.** Nutrition knowledge at 0 and 12 months postpartum by lactation groups.

[ab]Bars with different superscripts are significantly different ($p$<0.05).

[cd]Bars with different superscripts are significantly different ($p$<0.05).

**Knowledge, Weight Status, and Information Sources**

Women who had < 5% weight retention during the first postpartum year had greater nutrition knowledge at 0 and 12 months (Figure 3.3). Controlling for demographic and lactation score variables did not eliminate the statistical significance. However, entering baseline scores as a covariate did reduce statistical significance (56.4±1.2 *vs.* 54.0±1.0, $P<.10$). At 0 months, those with smaller weight retentions were more cognizant of the relative amounts of fiber foods, (44% *vs.* 25%, $P<.05$), and energy values of "low-fat" *vs.* "regular" food items (85% *vs.* 65%, $P<.05$). At 1 year, these women also knew more about the relative amounts of protein in foods (69% *vs.* 46%, $P<.01$), energy contents of foods (73.1% *vs.* 48.9%, $P<.05$) and the relationship of a folic acid deficiency to spina bifida (73% *vs.* 53%, $P<.05$).

Nutrition knowledge did not vary according to the source of nutrition information initially (Figure 3.4). After 1 year, only those who relied on family and TV as sources of nutrition information had a significant increase in knowledge (53.5±0.8 *vs.* 58.2±1.2, and 54.2±0.8 *vs.* 58.1±1.7, respectively). A comparison of users and non-users of individual sources showed greater knowledge among those who relied on books and magazines (57.6±1.4 *vs.* 53.4±1.0, $P<.05$), nutrition labels (59.9±2.3 *vs.* 54.2±0.9), the Internet (60.5±2.8 *vs.* 54.3±0.9, $P<.05$), family (58.2±1.5 *vs.* 53.5±1.0, $P<.05$), and a nurse (58.7±1.8 *vs.* 53.9±1.0, $P<.05$).

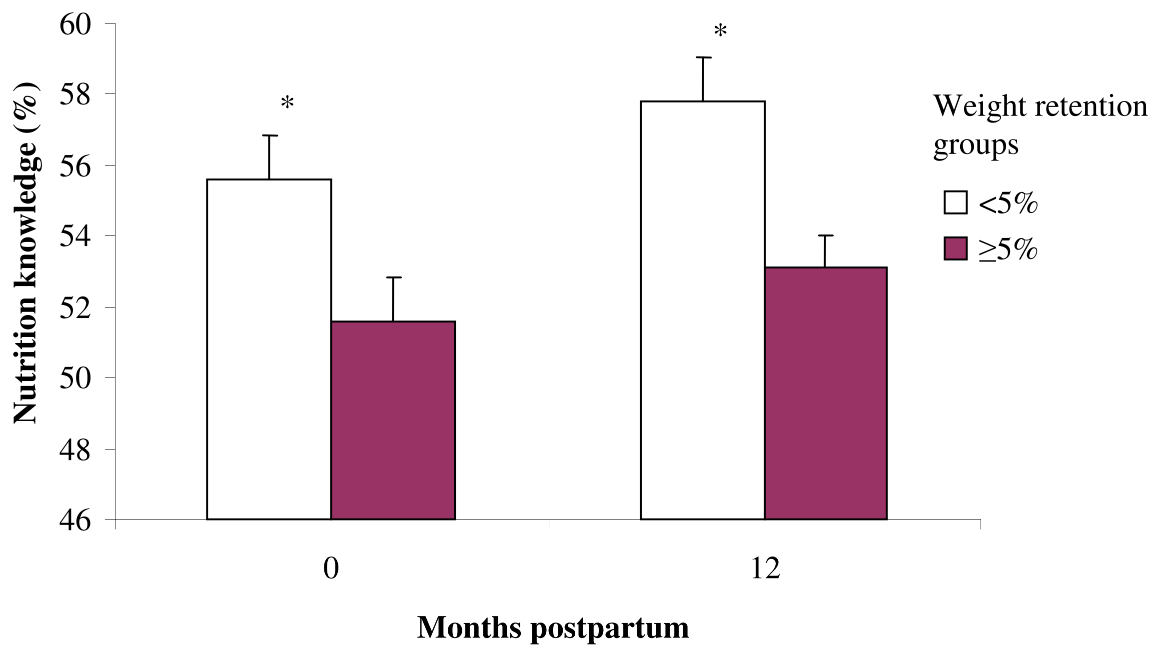



**Figure 3.3**. Nutrition knowledge scores at 0 and 12 months postpartum by weight retention groups.

*Significantly different than ≥5% weight retention group at 0 and 12 months postpartum ($p$<0.05).

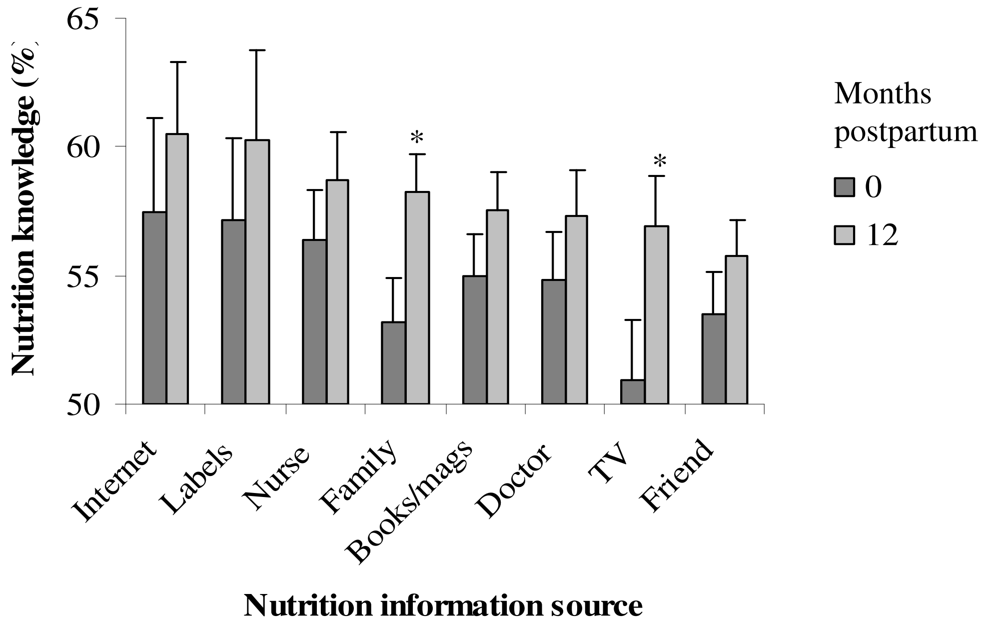



**Figure 3.4**. Nutrition knowledge scores at 0 and 12 months by nutrition information source.

*Within nutrition information source categories, significantly different than 0 months postpartum ($p$<0.05).

## DISCUSSION

These results indicate that women who had a better understanding of nutrition retained less weight at 1 year postpartum than those who exhibited lower scores on a nutrition knowledge test. This is the first observational study of nutrition knowledge related to weight status in low-income women during their first year following childbirth.

Two intervention studies were designed to enhance knowledge, but did not specifically measure nutrition knowledge (O'Toole et al. 2003, Leermaker et al. 1998). At 6 – 18 months after receiving instructions to reduce fat and energy intake and increase physical activity, Leermaker et al. (1998) reported that women who received the intervention lost more weight than controls (7.8 kg *vs.* 4.9 kg, $P < .05$, respectively). In a similar study by O'Toole et al. (2003), intervention subjects had a greater weight reduction than controls given only brochures (7.3 kg *vs.* 1.3 kg, respectively). In both studies, participants were primarily well-educated Non-Hispanic Whites, as opposed to our tri-ethnic, low-income mothers.

Previously, Klohe-Lehman et al. (2006) found an inverse relationship between knowledge and weight status in low-income, tri-ethnic women with children. This study consisted of eight weekly classes that promoted healthy eating, physical activity, and behavioral modification. Women were grouped as responders or non-responders in terms of weight loss. Responders had higher nutrition knowledge on both pre- and post-tests, with this trend persisting even when adjusted for initial scores. In our study low-income women with higher knowledge had less weight retention after one year following childbirth. Similar interventions in *non-postpartum* women also have observed that nutrition knowledge is associated positively with enhanced weight loss in U.S. African American (Auslander et al. 2002) and Swedish women (Bjorkelund et al. 2000). Collectively, these findings suggest that knowledge of nutrition may have a significant impact on the maintenance of a healthful weight status.

In our multi-ethnic study, Non-Hispanic White women had higher scores of nutrition knowledge than both African Americans and Hispanics. Other non-postpartum studies have reported that Non-Hispanic Whites have greater knowledge of nutrition than other ethnicities (Levy et al. 2003, Boulanger et al. 2002, Papakonstantinou et al. 2002, Parmenter et al. 2000). These differences have been attributed to educational disparities (National Center for Education Statistics 2006). Past studies have observed a comparable relationship between education and weight status among non-postpartum U.S. adult women (Lewis et al. 2005, Mack et al. 2004). Within our sample 50% of those with college education were Non-Hispanic White. Yet, scores of Non-Hispanic Whites remained significantly higher than that of the other ethnic groups, even when adjusted for education level.

One possibility for the higher scores of Non-Hispanic Whites is the difference *source* of nutrition information. The use of the Internet and books/magazines was associated with enhanced knowledge, and more Non-Hispanic Whites utilized these resources. Two recent surveys of U.S. men and women of mixed-income levels also reported a positive correlation between Internet use for health information and education level (Baker et al. 2003, Licciardone et al. 2001). Ethnicity (Licciardone et al. 2001) and income level (Baker et al. 2003) were not related to Internet use and, but education was positively related to income. In our sample, educational disparities could not have been a result of financial status, as all of our subjects were low-income.

African Americans and Hispanics were more likely to seek nutritional advice from friends or family members than Non-Hispanic Whites. Other research in low-income minority women also found that friends and family were a major source of nutrition information (Lewallen et al. 2004, Draton-Brooks and White 2004, James et al. 2004), and they may lack Internet access (Kind et al. 2005). It is conceivable that the accuracy of advice from friends and family may be less factual than that found on the Internet or in printed materials.

Health professionals were a significant source of nutrition information for our subjects, but this wasnot related to weight retention. This lack of association is not surprising as public health clinics tend to focus on the health of the child during postpartum, rather than weight reduction in mothers. In our study, more than half of the subjects received nutritional advice from a physician immediately following birth. This result is encouraging, as research suggests that physicians rarely provide nutritional counseling to their patients (James et al. 2004, Eaton et al. 2002).

In our study 15% of the women used nutrition labels, a figure which is lower than other low-income and minority populations (Satia et al. 2005, Perez-Escamilla et al. 2002, McArthur et al. 2001). However, those who read nutrition labels had greater weight loss (7.1 kg *vs.* 3.0 kg, $P<.05$, respectively) and nutrition knowledge than those who did not. With regards to weight loss, this result parallels that by Krummel et al. (2004), who found that label use was more common in WIC-enrolled postpartum women actively trying to lose weight; yet, their study population was predominantly Non-Hispanic White (91%). In terms of knowledge, Papakonstantinou et al. (2002) also reported that label users had better knowledge of fats, vitamins, and energy balance than non-users in a sample of predominantly Non-Hispanic White, well-educated, female sample of non-postpartum adults. In our study of tri-ethnic women, the same was true for label users and questions related to protein and fat content of foods and diet/health relationships.

In the present research, breastfeeding for an extended amount of time was associated with higher nutrition knowledge scores. This remained significant even after controlling for education. Havas et al. (1998) also noticed that breastfeeding WIC-enrolled participants who were predominantly African American were more likely to know the recommended servings of fruits and vegetables. The same was true in the present research.

The majority of our postpartum subjects were cognizant of the relationship between folic acid deficiency and spina bifida. Sen et al. (2004) also reported that *pregnant* women were aware of the importance of folic acid in the prevention of neural tube defects; the sample was primarily Non-Hispanic White and mid-upper class. Over 40% of women in our study had a correct understanding of the relative fiber contents of selected foods. In two larger studies of predominantly Non-Hispanic White, well-educated U.S. adult men and women, the majority of subjects (~ 85% Patterson et al. 1995, and 64% Sapp and Jensen 1997) identified foods with higher fiber content. Yet, both of these studies reported that cognition of this concept declined, as socioeconomic status and education decreased, which more closely resembles our study sample.

A minority of women accurately answered questions regarding fat and energy content of foods. However, these subjects retained, on average, 3 kg less than those who did not at one year postpartum. Two other investigations observed a positive association between a greater knowledge of fat and energy content and healthful weight status (Klohe-Lehman et al. 2006, Speakman et al. 2005). Collectively, these findings suggest that knowledge of fat and energy content of food promote healthful weight status.

## CONCLUSIONS

Assessment of nutrition knowledge in early postpartum can help dietetics professionals identify women who may be at risk for retaining excessive weight. This study has shown that African American and Hispanic women, who tended to have lower nutritional knowledge, had greater postpartum weight retention than Non-Hispanic Whites. Thus, minority women should receive special attention. Breastfeeding was found to be positively associated with nutrition knowledge and lower weight retention, and should be encouraged by health care professionals. The use of the Internet and printed materials were observed to be effective resources of nutrition education for this population of low-income women and should be made available to them. Curricula to promote weight loss should focus on the fat and energy content of foods, as this knowledge was inversely related to weight retention.

## Chapter 4: Nutrient Adequacy and Weight Status in Low Income, Tri-ethnic Women in the First Year Postpartum


### ABSTRACT

**Objective:** To measure nutrient intake of low-income, tri-ethnic women in the first year postpartum and evaluate its relationship to weight status in low-income and minority women.

**Design**: Subjects visited a research site at 1.5, 3, 6, and 12 months postpartum where dietary data were collected in the form of one 24-hour recall and 2 days of diet records. Participants were classified as either normal weight (BMI ≤ 25) or overweight/obese (BMI > 25), and the BMI groups were tested for differences in nutrient intake over the first postpartal year.

**Subjects/settings:** Study population (n = 182) was a sample of tri-ethnic, low-income women were recruited in the hospital 0 - 1 day after giving birth in the southwestern U.S. Eligibility requirements included Medicaid-qualified (income ≤ 185 % of the Federal Poverty guideline); ≥ 18 years of age; delivery of a healthy singleton; no occurrence of pregnancy-related defects.

**Statistical analyses performed:** Descriptive statistics were used to describe demographic characteristics, means/ranges of nutrient intakes. BMI groups were examined for relationships with nutrient intakes at 1.5, 3, 6, and 12 months postpartum using a 3 X 2 analysis of variance (ANOVA) for each time period separately. Repeated-measures ANOVAs assessed changes in intakes over time. Chi-square tests were used to ascertain associations between demographic and BMI groups.

**Results:** Overweight/obese women had a greater percentage of energy from carbohydrates than their normal weight counterparts (52.5 % vs. 49.6%, $p<0.05$). Less than half of the population met the recommendations for folate, calcium, magnesium, and vitamins $B_6$, D, E and C at all time points, regardless of ethnicity, BMI and lactation status.

**Conclusions:** Findings from this study emphasize the nutritional inadequacies of low-income, minority women during the first year postpartum.

## INTRODUCTION

An epidemic of obesity has been developing in the United States (U.S.) at an alarming rate. Current estimates are that more than 64% of people in the U.S. are overweight or obese as defined by a body mass index (BMI) >25 kg/m² (Fried et al, 2003). The concern over obesity is its association with an increased risk for developing co-morbidities, such as heart disease, high blood-cholesterol, type II diabetes, cancer, and glucose intolerance (Healthy People 2010). In 2003, medical expenditures related to treating health problems related to obesity cost the U.S. an estimated $75 billion dollars, half of which were paid for from Medicare and Medicaid funds (Finkelstein et al, 2004).

Obesity affects women (34%) more than men (27.7%), as two thirds of all women in the U.S. between the ages of 20 and 74 are classified as either overweight or obese (Center for Disease Control, 1999-2000). Those who are low-income, belong to a racial/ethnic minority group (Mokdad et al, 2003, Kristal et al, 1999), or are of childbearing age (Darnton-Hill et al. 1998, Healthy People 2010) are at particular risk. Furthermore, weight gain linked to childbearing, as well as lifestyle changes that may occur as the result of having a new child, increase a woman's likelihood of becoming overweight or obese. Numerous studies show that approximately one-fifth of women are more than 5 kg heavier at 6 to 18 months postpartum as compared to pre-pregnancy weight (Schaunberger et al. 1992, Ohlin et al. 1996, Parker et al. 1993, Keppel et al. 1993). It is critical, therefore, to explore the influences of diet on weight in the period following childbirth.

The purpose of this study was to monitor nutrient intake of low-income, tri-ethnic women in the first year postpartum and evaluate its relationship to weight status. No intervention was provided in order to capture usual dietary behavior during this time period.

## METHODS

### Study Design

A sample of tri-ethnic, low-income women were recruited in the hospital 0 - 1 day after giving birth to a healthy singleton. Information was obtained on prepregnancy weight status and socio-demographic variables, such as ethnicity, age, parity, education level, and marital status. Subjects visited the research site at 1.5, 3, 6, and 12 months postpartum where dietary data were collected in the form of one 24-hour recall and 2 days of diet records. Weight status was measured during each clinic visit; height was determined at 1.5 months. Participants were classified as either normal weight (BMI $\leq$ 25) or overweight/obese (BMI > 25), and the BMI groups were tested for differences in nutrient intake over the first postpartal year.

### Subjects

Subjects consisted of 182 women out of a larger population derived from the Austin New Mother's Study (Walker et al., 2004). Eligibility requirements included Medicaid-qualified (income $\leq$ 185 % of the Federal Poverty guideline); $\geq$ 18 years of age; Caucasian, African American, or Hispanic; delivery of a healthy singleton; fluency and literacy in English; and no occurrence of pregnancy-related defects and disease conditions. The study was approved by the Institutional Review Board of The University of Texas at Austin, and written informed consent was obtained from all participants.

### Anthropometrics

Height was measured at 1.5-months to the nearest 0.1 centimeter using a stadiometer mounted to a wall. Subjects were instructed to have the back of their head, shoulders, and buttocks touching the stadiometer while the measurement was taken. Weight was measured to the nearest 0.1 kilogram at each clinic visit using a calibrated digital scale (Fairbanks Portable Digital Scale, Kansas City, MO). For all measurements, participants were asked to remove shoes, jackets or sweaters, hats, and all contents from their pockets. Height and weight were used to calculate body mass index [BMI = weight (kg) /height ($m^2$)].

**Nutrient Intake**

One 24-hour dietary recall and two food records were collected at each clinic visit. A trained nutritionist or nurse conducted 24-hour dietary recalls using food models, measuring cups and spoons, and common food packages. Instructions were given for accurate estimation of portion sizes and methods of recording diet records. Emphasis was placed on including brand names, preparation of foods eaten (when applicable), as well as added fats, sweeteners, and condiments. Nutrient content was determined using The Food Processor (version 7.81, ESHA). Food items that did not have exact matches in the database were replaced with individual or composite foods that most closely represented the missing item. Data were then imported into a statistical software package (SPSS, version 11.5, Chicago, Ill.) for statistical analysis. A 3-day average of all nutrient values was obtained by combining the 24-hour dietary recall and the 2 days of diet records.

Mean energy intakes of individuals were compared to values for total energy expenditure (TEE). The TEE is the amount of energy required to maintain weight in an individual, and accounts for the thermic effect of food, physical activity, thermoregulation, and energy used to deposit new tissues and the production of milk (Dietary Reference Intakes, 2004). The following equation was used to calculate the TEE for each subject:

$$TEE = 387 - (7.31 \text{ X age in years}) + PA[(10.9 \text{ X weight in kg}) + 660.7 \text{ X height in m})]:$$

where PA represents the values for the various physical activity levels (1.00 = sedentary, 1.12 = low active, 1.27 = active, 1.45 = very active). The energy cost of lactation was compensated by the addition of 330 kilocalories for the first 6 months of lactation, and 400 kilocalories for the remainder (Institute of Medicine 2002). To estimate energy expenditure, physical activity levels were assessed via two items that were part of The Self-Care Inventory scale (Pardine, n.d.), asking participants how often they exercised and participated in some form of physical activity.

Percent energy as protein, fat, and carbohydrates were compared to the acceptable macronutrient distribution ranges (AMDRs) for carbohydrates (45% – 65%), fat (20% - 35%), and protein (10% - 35%) (Institute of Medicine 2002). Mean intakes for vitamins and minerals were calculated for life-stage groups according to age and lactation status. The Estimated Average Requirements (EAR) were used to determine nutrient adequacy was used, as this is the preferred method for determining vitamin and mineral in adequacy among population groups (Dietary Reference Intakes 2002). The proportion of the group with intakes below the EAR was used to assess inadequacy. For nutrients without an EAR, the adequate intake (AI) was used for comparison. Although the proportion below the AI cannot be used to determine inadequacy, groups with mean intakes above the AI can be considered to have adequate intakes for a nutrient (Dietary Reference Intakes 2002).

**Statistical Analysis**

Data were analyzed using the Statistical Program for the Social Sciences (SPSS 11.5, Chicago, Ill). Descriptive statistics were used to describe the proportions of the ethnic groups, BMI groups, and means and ranges of nutrient intakes. The BMI groups were examined for relationships with nutrient intakes at 1.5, 3, 6, and 12 months postpartum using a 3 X 2 (ethnicity X BMI groups) analysis of variance (ANOVA) for each time period separately. A repeated-measures ANOVA was used to test for changes in intakes over time. Chi-square tests were used to determine whether there was a statistically significant association between ethnicity and BMI weight classification. All analyses were tested for significance at the $p<0.05$ level when appropriate.

## RESULTS

### Subjects

Demographic characteristics of the study sample are in Table 4.1. The majority of the women was Hispanic, average 22 years of age (range 18 – 37), and a parity of 1, had a partial high school education, and was married or living with a partner.

### Weight Status

Prior to pregnancy, more than half (53.3%) of the women had normal weights (BMI < 25). Of this group, 41% were Caucasian, while the Hispanics comprised nearly half of the overweight/obese group. By 1.5-months postpartum the proportion of overweight or obese women increased to nearly two-thirds ($p<0.001$), and remained so throughout the first year postpartum. A greater proportion of Caucasian women who were overweight or obese at 1.5 months postpartum had reduced their BMI status to normal by 1 year ($\chi^2 = 12.7$, d.f. = 6, $p<0.05$). At 1 year, African Americans (64.4%) and Hispanics (66.7%) were more likely than Caucasians (43.5%) to be overweight or obese ($\chi^2 = 4.56$, df=1, $p<.03$ and $\chi^2 = 7.37$, df=1, $p<.01$, respectively). The majority of women (83%) who were overweight or obese during prepregnancy maintained that weight status at 1 year postpartum.

### Lactation Status

Less than 40% of the mothers were lactating at 1.5 months postpartum, and this value declined steadily throughout postpartum. Nearly half of the Caucasian women

**Table 4.1.** Profile of the sample (n = 182)

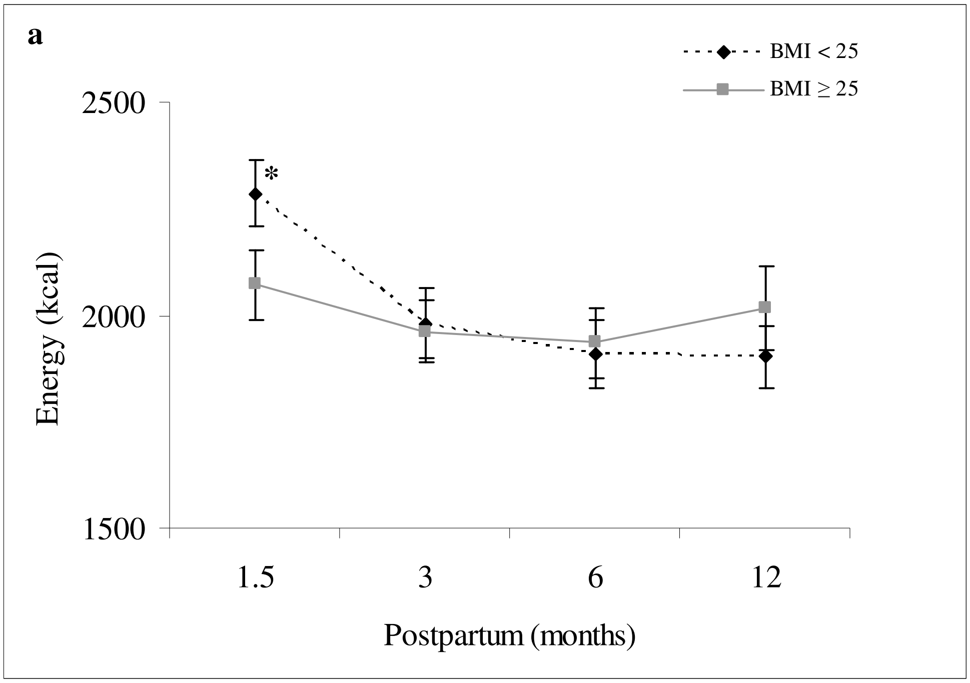
| Item | n | (%) |
|---|---|---|
| **Ethnicity** | | |
| Caucasian | 62 | (34.1) |
| African American | 45 | (24.7) |
| Hispanic | 75 | (41.2) |
| **Age** | | |
| ≤ 20 y | 66 | (36.3) |
| 21 – 24 y | 76 | (42.3) |
| ≥ 25 y | 40 | (21.4) |
| **Parity** | | |
| 1 | 73 | (40.1) |
| 2 | 69 | (37.9) |
| 3 | 40 | (22.0) |
| **Education** | | |
| Partial high school | 74 | (40.6) |
| High school graduate | 65 | (35.7) |
| Partial/college graduate | 43 | (23.6) |
| **Marital status** | | |
| Married, living with partner | 115 | (63.2) |
| Single, not living with partner | 67 | (36.8) |

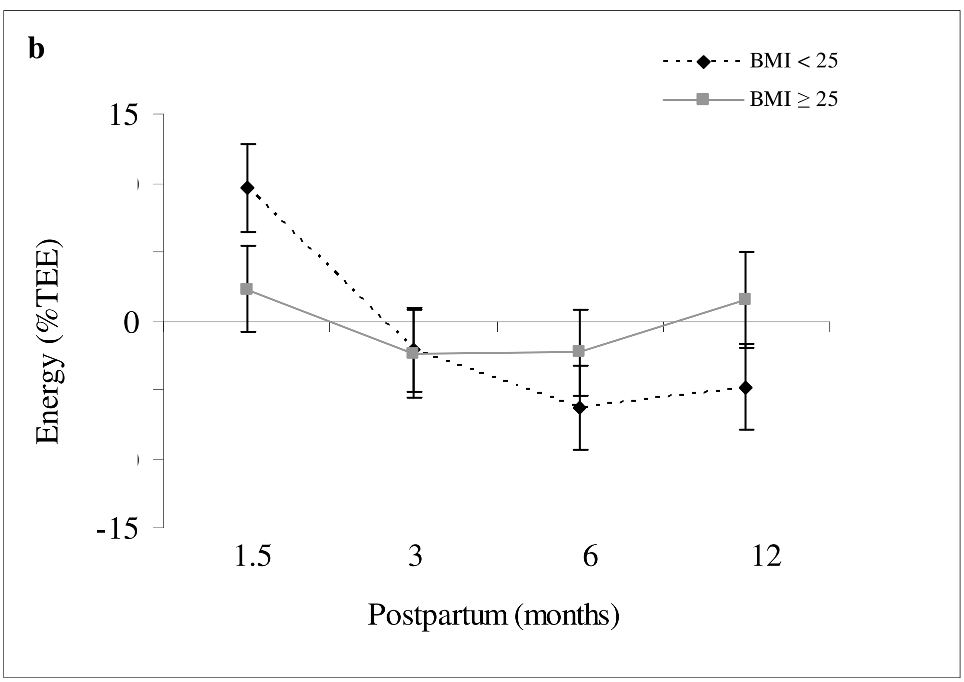
were lactating at 1.5 months, as compared to approximately one-third of the African American or Hispanic women ($\chi 2=3.9$, df=2, $p<0.1$). Normal weight women were more likely than overweight/obese women to be lactating at 1.5 months postpartum ($\chi 2=7.0$, df=1, $p<0.01$). Women who were of normal BMI at 1 year were more likely to have breastfed at 1.5, 3, and 6 months postpartum.

**Mean Energy and TEE**

Mean energy intakes over time by BMI groups and by ethnicity are presented in Figure 4.1a and Figure 4.2a, respectively. Data presented have been adjusted for energy requirements based on lactation status. For all women, mean daily energy intake was highest at 1.5 months postpartum (2159 ± 612 kcal/d, $p<.001$) compared to all other time points. Within ethnic groups, pair-wise comparisons showed that this was also true for Caucasians and African Americans (significant at $p<.05$ level). There was a significant effect for BMI groups and total energy, as normal weight consumed more total energy (2286 ± 576 kcal/d) than overweight/obese individuals (2071 ± 623) [$F(1,176)=7.70$, $p<.01$]; this difference was not present during the remainder of the year. More than half (52.7%) of the sample had energy intakes in excess of their referenced-height TEE at 1.5-months; this percentage did not differ according to BMI, ethnic groups, lactation.
At 3 months, average total energy for the sample decreased significantly (1969 ± 589 kcal/d, $p<0.002$) from early postpartum. Approximately 43% of all women exceeded their TEE values. Hispanics were more likely than African Americans to have mean energy values greater than their TEE (53.3% vs. 28.9%, $\chi^2 = 6.82$, df = 1, $p<0.01$).

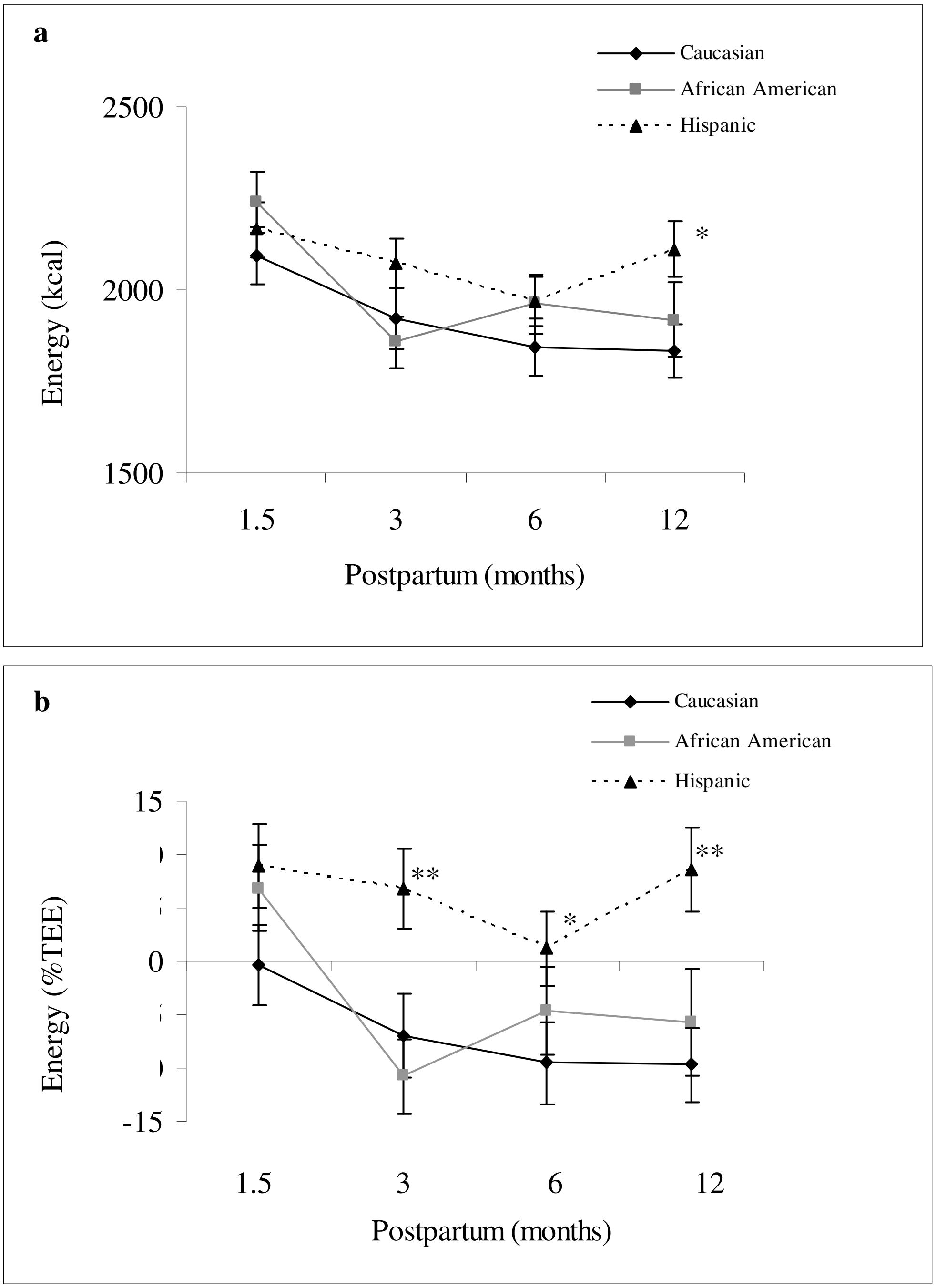
**Figure 4.1**. The a) mean ± SEM energy intakes and b) % Total Energy Expenditure (TEE) during postpartum, according to BMI groups.




* BMI < 25 significantly different than BMI ≥ 25 (p<0.05).

**Figure 4.2.** The a) mean ± SEM energy intakes and b) % Total Energy Expenditure (TEE) during postpartum, according to ethnicity.




* Hispanics significantly different than Caucasians (p<0.05).
** Hispanics significantly different than Caucasians and African Americans (p<0.05).

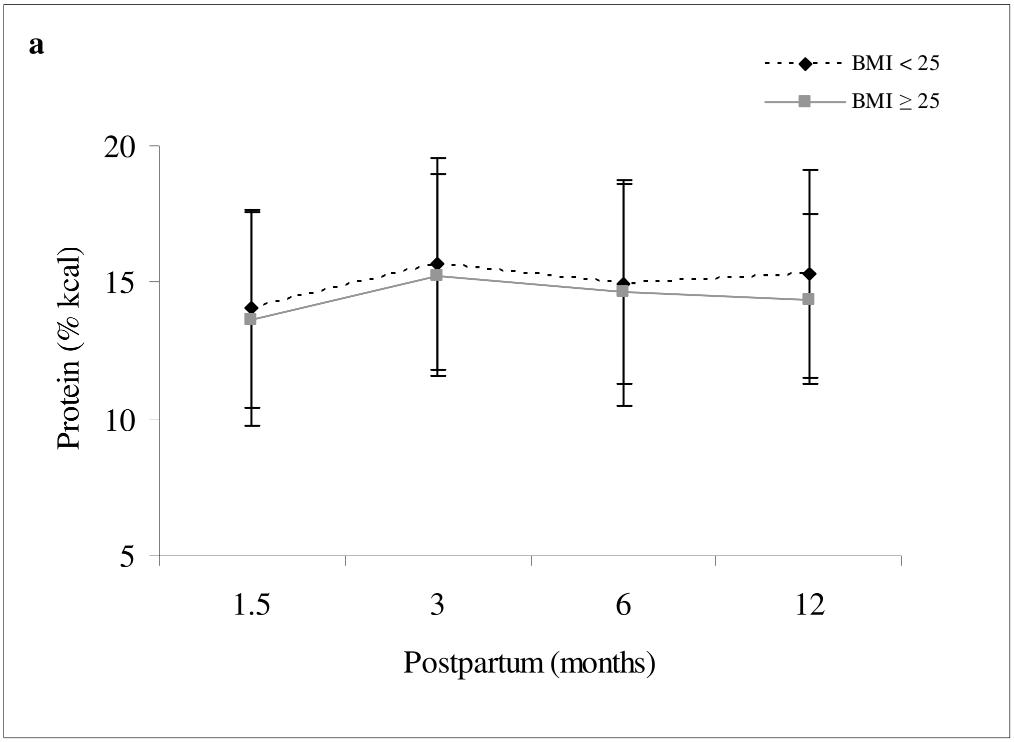
Caloric intakes and the percent of women above their TEE values did not increase significantly at 6 months postpartum. At 1 year, the mean energy reported in the diets was 1969 ± 638 kcal/d. Repeated measures ANOVA did not reveal any significant differences in the rate of change in energy over time between ethnicities. However, Hispanics consumed more kilocalories than Caucasians (2099 ± 653 kcal/d vs. 1833 ± 566, $p<.01$) (Figure 4.2a) and were more likely to have total energy values above the TEE ($\chi^2$=8.59, df=1, $p<0.005$).

**Percent Energy from Protein, Fat, and Carbohydrates**

At 1.5 months postpartum, the mean % energy from protein, fat, and carbohydrates was 13.7%, 50.2%, and 32.4%, respectively. These values did not differ significantly according to BMI (Figure 4.3), lactation, or ethnicity (Figure 4.4). One-fifth of the population was below the AMDR for carbohydrates. Fat intakes greater than 35% were observed in 38.5% of our subjects at 1.5 months postpartum; these climbed significantly at 3 months postpartum to 47.8% ($p<0.05$) and decreased non significantly to 40% for the remainder of the year. A repeated measures ANOVA revealed a significant change over time from 1 to 3 months postpartum in % energy as protein [$F(1,10.5)=10.7$, $p<0.001$] and fat [$F(1,49.3)=5.27$, $p<0.02$)] as these increased (15.5%, $p<0.05$; 34.4%, $p<0.02$), respectively.

At 1 year postpartum, BMI status was statistically relevant as overweight/obese women had a greater percentage of energy from carbohydrates than their normal weight counterparts (52.5 % vs. 49.6%) [$F(1,176)=3.98$, $p<0.05$]. At all time points, dietary

**Figure 4.3.** The mean ± SEM % energy from a)protein, b) c arbohydrates, And c) fat during postpartum, according to BMI groups.



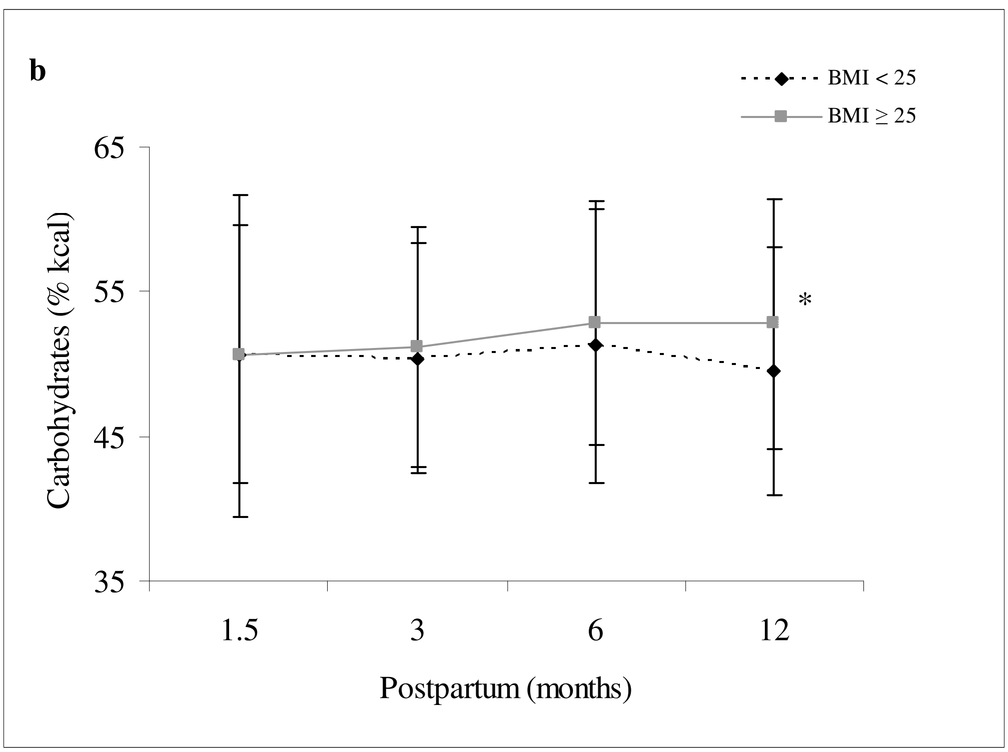
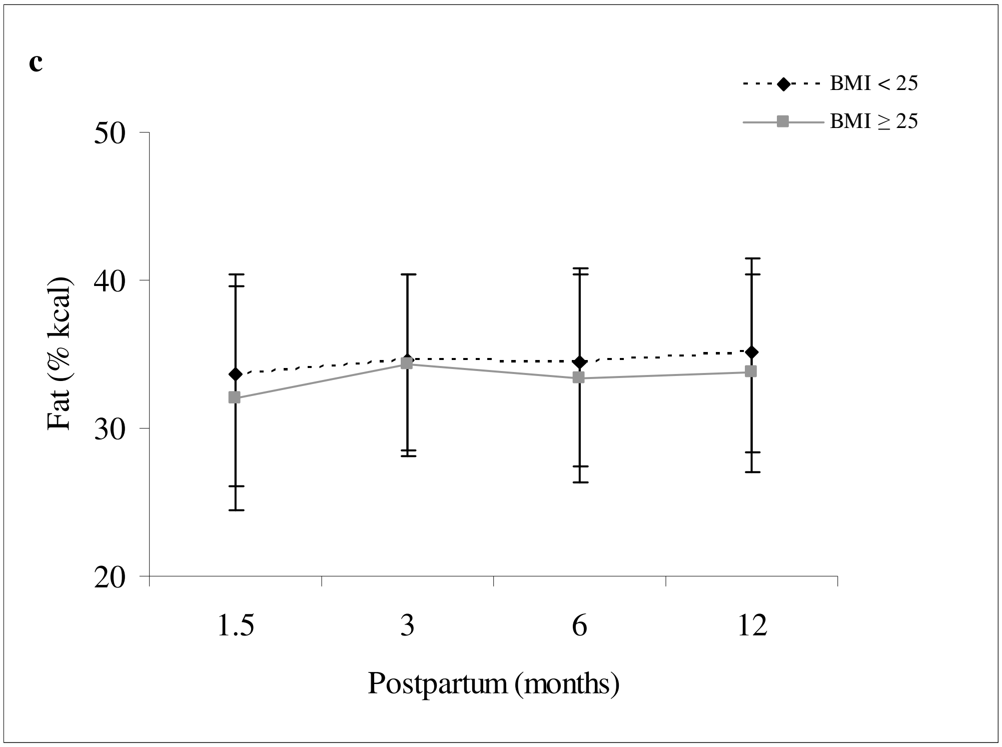
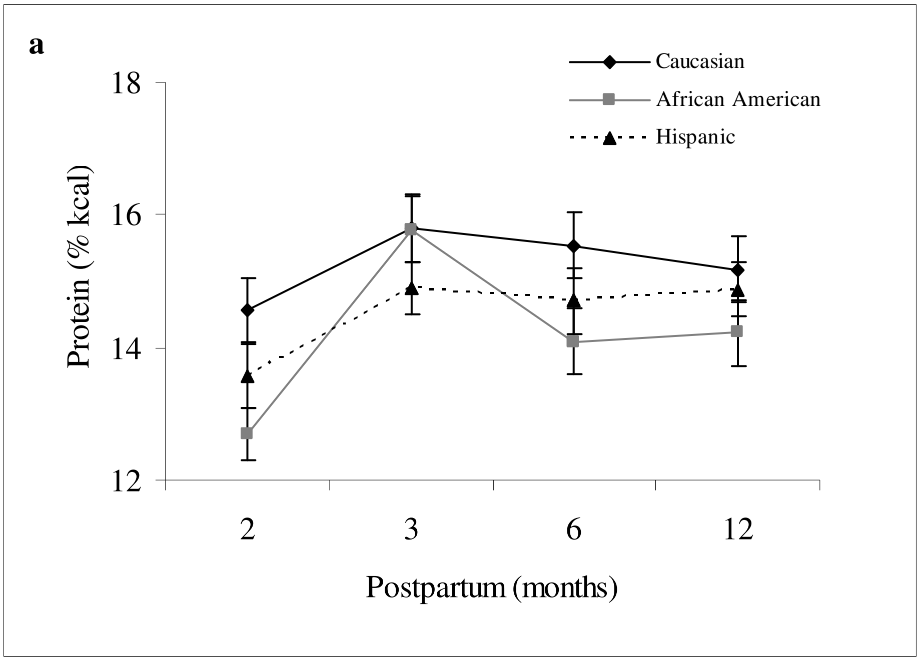



Figure 4.3, cont.




* BMI < 25 significantly different than BMI ≥25 ($p<0.05$).

**Figure 4.4**. Mean % energy from protein (a), c arbohydrates (b), and fat (c)over time according to ethnicity.



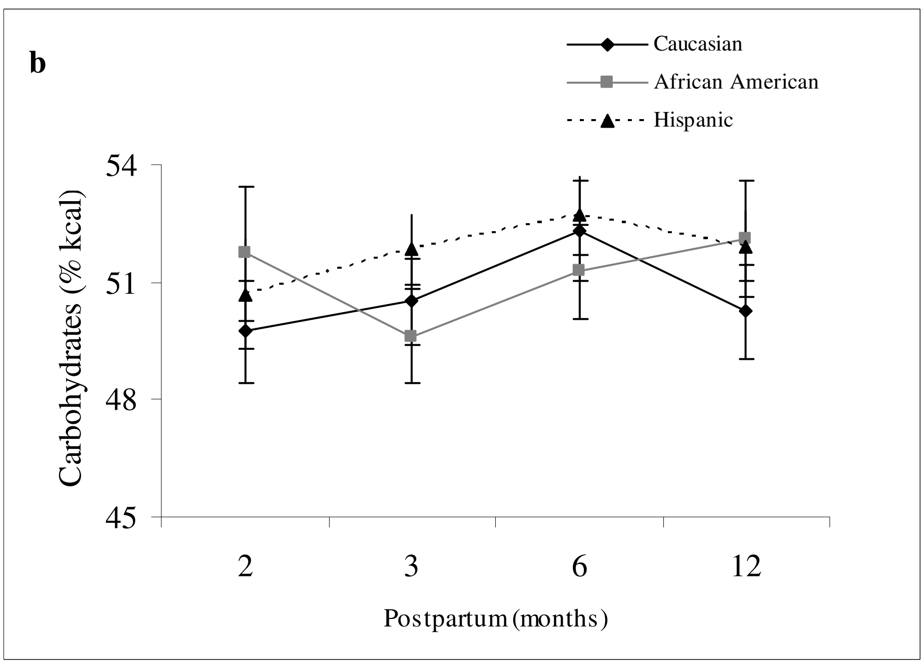
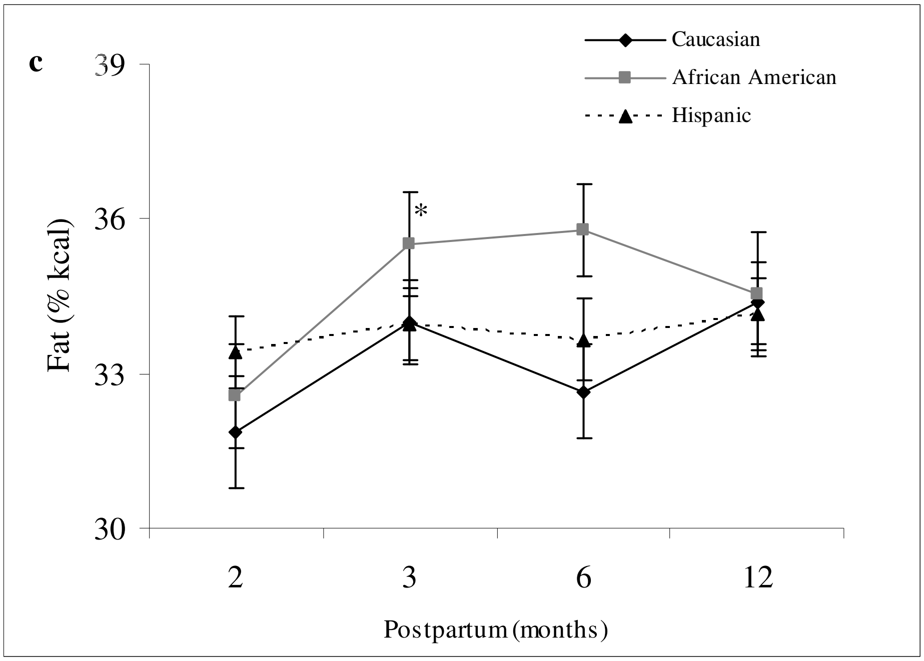



Figure 4.4, cont.




* African Americans significantly different than Caucasians (p<0.05).

fiber intake was greater in breast-feeding than non-lactating women ($p<0.05$), but this did not differ according to BMI status.

Within ethnic groups, % kilocalories from protein was lowest at 1.5 months postpartum ($p<0.05$) for Hispanics and highest at 3 months in African American women (Figure 4.2b). African Americans also had a smaller % energy from fat at 1.5 months compared to 3 and 6 months postpartum (Figure 4.2d, $p<0.05$). African American women had higher values (35.8%) for % energy from fat than Caucasians (32.7) at the 6 month time point only [$F(2,176)=3.47$, $p<0.03$].

**Vitamin and Mineral Status**

A display of the intakes of vitamins and minerals as compared to % < EARs and AIs is listed in Table 4.2a - d. Less than half of the population met the recommendations for folate, calcium, magnesium, and vitamins $B_6$, D, E and C at all time points, regardless of ethnicity, BMI and lactation status. Lactating women had higher intakes of calcium and pantothenic acid (1.5 & 3 months) ($p<0.05$), vitamin D (1.5, 3, 12 months) ($p<0.05$), and magnesium (all time points) than non-lactating women. Non-lactating women more frequently met or exceeded the EARs for phosphorus ($\chi^2 =6.34$, df=1, $p<0.01$) and iron ($\chi^2 =6.05$, df=1, $p<0.01$) than those who breastfed at 6 months ($p<0.05$).

Healthy weight women had greater levels of dietary vitamin $B_{12}$ and pantothenic acid than overweight/obese women at 1.5 months. There were no other statistically significant differences between BMI groups until 12 months, at which point normal weight women had greater intakes of calcium and vitamin D than overweight/obese

**Table 4.2a.** Daily vitamin and mineral intake according to estimated average requirements (EARs) or adequate intakes (AIs) by BMI groups at 1.5 months postpartum.

| Nutrient | EAR or AI[a] | | 1.5 months postpartum | | | |
|---|---|---|---|---|---|---|
| | | | Normal[b] (N = 74) | | Overweight/obese[c] (N = 108) | |
| | Lactating | Non-lactating | Mean[d] | %<EAR | Mean | %<EAR |
| **Antioxidants** | | | | | | |
| Vitamin C (mg) | 100 | 60 | 85±9.5 | 66 | 75±7.2 | 60 |
| Vitamin E (mg) | 16 | 12 | 6.0±0.6 | 92 | 5.4±0.4 | 95 |
| Selenium (mg) | 59 | 45 | 56±3.2 | 1 | 50±2.8 | 5 |
| **B vitamins** | | | | | | |
| Thiamin (mg) | 1.2 | 0.9 | 1.2±0.05 | 38 | 1.1±0.05 | 47 |
| Riboflavin (mg) | 1.3 | 0.9 | 1.5±0.07 | 22 | 1.3±0.06 | 37 |
| Niacin (mg)[e] | 13 | 11 | 28±1.2 | 4 | 24±1.0 | 8 |
| Vitamin $B_6$ (mg) | 1.7 | 1.0 | 1.3±0.07 | 62 | 1.1±0.05 | 64 |
| Folate (µg) | 450 | 320 | 232±13.0 | 89 | 200±11.2 | 89 |
| Vitamin $B_{12}$ (µg) | 2.4 | 2.0 | 3.6±0.3* | 30 | 2.8±0.2 | 41 |
| Pantothenic acid (mg) | *7* | *5* | *3.1±0.2** | *93* | *2.4±0.1* | *98* |
| **Bone-related nutrients** | | | | | | |
| Calcium (mg) | *1000* | *1000* | *737±37.7* | *80* | *614±35.6* | *90* |
| Phosphorus (mg) | 580 | 580 | 1004±40.9 | 9 | 844±39.4 | 27 |
| Magnesium (mg) | 300 | 255 | 185±8.4 | 88 | 156±7.2 | 94 |
| Vitamin D (µg) | *5.0* | *5.0* | *3.6±0.4* | *80* | *2.6±0.2* | *89* |
| Zinc (mg) | 10.4 | 6.8 | 9.1±0.5 | 50 | 8.0±0.4 | 55 |
| Copper (µg) | 1000 | 700 | 815±40.0 | 58 | 714±31.4 | 66 |

Figure 4.2a, cont.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Other micronutrients** | | | | | | |
| Iron (mg) | 6.5 | 8.1 | 14±0.6 | 11 | 12±0.5 | 18 |
| Manganese (mg) | *2.6* | *1.8* | *1.6±0.1* | *81* | *1.3±0.09* | *78* |
| Vitamin A (µg RAE)[f] | 900 | 500 | 676±49.9 | 66 | 565±43.8 | 62 |

[a] EARs in ordinary font, AI's are italicized.
[b] BMI < 25
[c] BMI ≥ 25
[d] Mean ± SEM.
[e] Niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan.
[f] Retinol activity equivalents (RAEs). 1 RAE = 1 µg retinol, 12 µg β-carotene, 24 µg α, or 24 µg β-cryptoxanthin.
* p<.05, ** p<.01 for significant differences between BMI groups.

**Table 4.2b.** Daily vitamin and mineral intake according to estimated average requirements (EARs) or adequate intakes (AIs) by BMI groups at 3 months postpartum.

| Nutrient | EAR or AI[a] | | 3 months postpartum | | | |
|---|---|---|---|---|---|---|
| | | | Normal[b] (N = 73) | | Overweight/obese[c] (N = 109) | |
| | Lactating | Non-lactating | Mean[d] | %<EAR | Mean | %<EAR |
| **Antioxidants** | | | | | | |
| Vitamin C (mg) | 100 | 60 | 70±6.9 | 65 | 74±5.7 | 55 |
| Vitamin E (mg) | 16 | 12 | 6.1±0.5 | 91 | 5.8±0.5 | 90 |
| Selenium (mg) | 59 | 45 | 50±3.2 | 1 | 52±2.9 | 1 |
| **B vitamins** | | | | | | |
| Thiamin (mg) | 1.2 | 0.9 | 1.1±0.05 | 50 | 1.1±0.05 | 44 |
| Riboflavin (mg) | 1.3 | 0.9 | 1.3±0.06 | 32 | 1.3±0.07 | 31 |
| Niacin (mg)[e] | 13 | 11 | 27±1.4 | 4 | 26±1.1 | 9 |
| Vitamin $B_6$ (mg) | 1.7 | 1.0 | 1.2±0.06 | 61 | 1.2±0.06 | 54 |
| Folate (µg) | 450 | 320 | 191±10.6 | 97 | 188±9.3 | 92 |
| Vitamin $B_{12}$ (µg) | 2.4 | 2.0 | 3.2±0.2 | 35 | 3.4±0.2 | 30 |
| Pantothenic acid (mg) | *7* | *5* | *2.8±0.2* | *96* | *2.4±0.1* | *99* |
| **Bone-related nutrients** | | | | | | |
| Calcium (mg) | *1000* | *1000* | *643±35.1* | *89* | *603±30.6* | *91* |
| Phosphorus (mg) | 580 | 580 | 900±35.9 | 18 | 872±40.6 | 28 |
| Magnesium (mg) | 300 | 255 | 168±9.6 | 92 | 155±6.5 | 93 |
| Vitamin D (µg) | *5.0* | *5.0* | *2.8±0.3* | *82* | *2.7±0.3* | *86* |
| Zinc (mg) | 10.4 | 6.8 | 8.7±0.5 | 51 | 8.8±0.4 | 40 |
| Copper (µg) | 1000 | 700 | 708±28.8 | 92 | 680±28.6 | 95 |

Table 4.2b, cont.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Other micronutrients** | | | | | | |
| Iron (mg) | 6.5 | 8.1 | 13±0.6 | 14 | 13±0.5 | 21 |
| Manganese (mg) | *2.6* | *1.8* | *1.3±0.09* | *84* | *1.3±0.07* | *75* |
| Vitamin A (μg RAE)[f] | 900 | 500 | 582±45.7 | 64 | 560±36.4 | 61 |

[a] EARs in ordinary font, AI's are italicized.
[b] BMI < 25
[c] BMI ≥ 25
[d] Mean ± SEM.
[e] Niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan.
[f] Retinol activity equivalents (RAEs). 1 RAE = 1 μg retinol, 12 μg β-carotene, 24 μg α, or 24 μg β-cryptoxanthin.
* p<.05, ** p<.01 for significant differences between BMI groups.

**Table 4.2c.** Daily vitamin and mineral intake according to estimated average requirements (EARs) or adequate intakes (AIs) by BMI groups at 6 months postpartum.

| Nutrient | EAR or AI[a] | | 6 months postpartum | | | |
|---|---|---|---|---|---|---|
| | | | Normal[b] (N = 74) | | Overweight/obese[c] (N = 108) | |
| | Lactating | Non-lactating | Mean[d] | %<EAR | Mean | %<EAR |
| **Antioxidants** | | | | | | |
| Vitamin C (mg) | 100 | 60 | 60±7.0 | 72 | 68±6.0 | 60 |
| Vitamin E (mg) | 16 | 12 | 5.8±0.6 | 93 | 6.1±0.8 | 92 |
| Selenium (mg) | 59 | 45 | 48±3.5 | 1 | 48±3.0 | 6 |
| **B vitamins** | | | | | | |
| Thiamin (mg) | 1.2 | 0.9 | 1.1±0.07 | 50 | 1.1±0.05 | 42 |
| Riboflavin (mg) | 1.3 | 0.9 | 1.3±0.07 | 28 | 1.3±0.06 | 29 |
| Niacin (mg)[e] | 13 | 11 | 24±1.5 | 9 | 24±1.2 | 15 |
| Vitamin $B_6$ (mg) | 1.7 | 1.0 | 1.1±0.07 | 62 | 1.2±0.07 | 56 |
| Folate (µg) | 450 | 320 | 182±10.9 | 97 | 195±12.9 | 94 |
| Vitamin $B_{12}$ (µg) | 2.4 | 2.0 | 3.0±0.3 | 46 | 3.3±0.3 | 32 |
| Pantothenic acid (mg) | *7* | *5* | *2.4±0.1* | *99* | *2.5±0.2* | *98* |
| **Bone-related nutrients** | | | | | | |
| Calcium (mg) | *1000* | *1000* | *627±33.2* | *93* | *619±31.5* | *89* |
| Phosphorus (mg) | 580 | 580 | 854±44.8 | 26 | 822±33.7 | 27 |
| Magnesium (mg) | 300 | 255 | 163±8.8 | 89 | 156±7.4 | 90 |
| Vitamin D (µg) | *5.0* | *5.0* | *2.7±0.3* | *85* | *2.7±0.3* | *86* |
| Zinc (mg) | 10.4 | 6.8 | 7.7±0.4 | 53 | 8.4±0.5 | 45 |
| Copper (µg) | 1000 | 700 | 679±38.9 | 74 | 691±32.4 | 64 |

Table 4.2c, cont.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Other micronutrients** | | | | | | |
| Iron (mg) | 6.5 | 8.1 | 12±0.6 | 19 | 12±0.6 | 21 |
| Manganese (mg) | *2.6* | *1.8* | *1.3±0.1* | *80* | *1.3±0.09* | *80* |
| Vitamin A (μg RAE)[f] | 900 | 500 | 615±70.3 | 61 | 586±43.9 | 56 |

[a] EARs in ordinary font, AI's are italicized.
[b] BMI < 25
[c] BMI ≥ 25
[d] Mean ± SEM.
[e] Niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan.
[f] Retinol activity equivalents (RAEs). 1 RAE = 1 μg retinol, 12 μg β-carotene, 24 μg α, or 24 μg β-cryptoxanthin.
* p<.05, ** p<.01 for significant differences between BMI groups.

**Table 4.2d.** Daily vitamin and mineral intake according to estimated average requirements (EARs) or adequate intakes (AIs) by BMI groups at 12 months postpartum.

| Nutrient | EAR or AI[a] | | 12 months postpartum | | | |
|---|---|---|---|---|---|---|
| | | | Normal[b] (N = 76) | | Overweight/obese[c] (N = 106) | |
| | Lactating | Non-lactating | Mean[d] | %<EAR | Mean | %<EAR |
| **Antioxidants** | | | | | | |
| Vitamin C (mg) | 100 | 60 | 64±7.3 | 67 | 75±6.6 | 58 |
| Vitamin E (mg) | 16 | 12 | 5.2±0.5 | 93 | 6.7±1.1 | 93 |
| Selenium (mg) | 59 | 45 | 50±3.0 | 4 | 49±3.0 | 3 |
| **B vitamins** | | | | | | |
| Thiamin (mg) | 1.2 | 0.9 | 1.1±0.06 | 39 | 1.2±0.06 | 39 |
| Riboflavin (mg) | 1.3 | 0.9 | 1.3±0.06 | 30 | 1.3±0.06 | 31 |
| Niacin (mg)[e] | 13 | 11 | 24±1.2 | 5 | 24±1.1 | 8 |
| Vitamin $B_6$ (mg) | 1.7 | 1.0 | 1.1±0.07 | 62 | 1.3±0.1 | 59 |
| Folate (µg) | 450 | 320 | 184±12.0 | 92 | 202±12.1 | 89 |
| Vitamin $B_{12}$ (µg) | 2.4 | 2.0 | 2.8±0.2 | 39 | 3.1±0.3 | 36 |
| Pantothenic acid (mg) | *7* | *5* | *2.4±0.1* | *99* | *2.4±0.2* | *96* |
| **Bone-related nutrients** | | | | | | |
| Calcium (mg) | *1000* | *1000* | *643±34.0*** | *88* | *570±26.9* | *92* |
| Phosphorus (mg) | 580 | 580 | 855±39.6 | 26 | 851±44.0 | 26 |
| Magnesium (mg) | 300 | 255 | 153±7.8 | 96 | 151±7.2 | 90 |
| Vitamin D (µg) | *5.0* | *5.0* | *3.0±0.3*** | *83* | *2.3±0.2* | *90* |
| Zinc (mg) | 10.4 | 6.8 | 7.7±0.4 | 54 | 8.6±0.5 | 42 |
| Copper (µg) | 1000 | 700 | 664±38.0 | 71 | 709±48.2 | 68 |

Table 4.2d, cont.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Other micronutrients** | | | | | | |
| Iron (mg) | 6.5 | 8.1 | 12±0.5 | 17 | 13±0.8 | 21 |
| Manganese (mg) | *2.6* | *1.8* | *1.3±0.2* | *83* | *1.5±0.2* | *78* |
| Vitamin A (μg RAE)[f] | 900 | 500 | 595±41.8 | 55 | 585±50.1 | 57 |

[a] EARs in ordinary font, AI's are italicized.
[b] BMI < 25
[c] BMI ≥ 25
[d] Mean ± SEM.
[e] Niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan.
[f] Retinol activity equivalents (RAEs). 1 RAE = 1 μg retinol, 12 μg β-carotene, 24 μg α, or 24 μg β-cryptoxanthin.
* p<.05, ** p<.01 for significant differences between BMI groups.

women. When controlling for lactation status the increased values of vitamin D ($p<0.05$) remained for normal weight women, but the significance disappeared for calcium.

Caucasian women had greater mean intakes of niacin, calcium, magnesium, and vitamins $B_{12}$ and D than African Americans; higher intakes of vitamin $B_6$ than Hispanics; and higher intakes of riboflavin and phosphorous than both African Americans and Hispanics at 1.5 months ($p<0.05$). Caucasians reported higher values for vitamin A than did Hispanics at the 3-month time point ($p<0.05$) and a greater proportion of Hispanics fell below recommendations for vitamin $B_{12}$ ($\chi= 6.31$, df=2, $p<0.04$). At 12 months, Caucasians had higher intakes of calcium than Hispanics ($p<0.04$), and more likely to have met the EAR for vitamin C than other ethnic groups ($p<6.45$, df=2, $p<0.04$), and Hispanics were less likely than other ethnic groups to consume suggested amounts of folate ($\chi=9.41$, df=3, $p<0.01$). African Americans had higher intakes of vitamin C as compared to Caucasians at each time point ($p<0.05$), and were more likely to achieve the EAR for niacin ($\chi=12.2$, df=3, $p<0.003$) at 12 months.

## DISCUSSION

These results suggest that a greater proportion of carbohydrates in the diet are associated with higher weight status at the end of the first postpartum year, as mean intakes of carbohydrates in our overweight/obese moms were increasingly higher than healthy weight women beginning at 3 months. This trend, however, was significant only at 12 months, and so we must interpret this finding with caution. However, a similar study of nutrition and exercise during early postpartum (0 – 4 months) did find that obese women ingested more carbohydrates than their normal weight counterparts as early as 24 hours after deliver, and again at 2 months (Morin et al, 1999). To further corroborate our findings, a number of recent clinical trails have compared the efficacy of a low-carbohydrate versus a low (25%) fat (Foster et al, 2003) or moderately low (<30%) fat (Brehem et al, 2003, Stern et al, 2004, Yancy et al, 2004) diet as a means of weight reduction . All of these indicated that the low-carbohydrate approach was more effective in inducing weight loss during the first 6 months. Beyond this time point the influence of the composition of the diet was minimized (Foster et al, 2003, Stern et al, 2004).

In contrast, weight status exclusive of dieting may show different relationships. An epidemiological study by Yang et al (2000) showed an inverse relationship between BMI and % energy as carbohydrates in a sample of U.S. women. Also, a report by Bowman and Spence (2002) found that diets of free-living adults in the U.S. who consumed a high-carbohydrate diet (≥ 55% energy) were lower in total kilocalories than low-carbohydrate diets (<30%), and those individuals were more likely have a BMI below 25.   Thus the lower BMIs associated with higher dietary carbohydrates in these studies appear to be a function of lower calories.  In our low-income women, the above was true only at early postpartum when weights were changing rapidly. When energy values did not differ, the trend was that higher carbohydrate intake was associated with greater body weights. Therefore, a true association may exist between higher carbohydrate intake and weight status, though more research is needed to fully explore this relationship.

Moreover, energy intakes in our sample did not differ between BMI groups except at 1.5 months postpartum.  During that period, the average caloric value reported by normal weight participants was greater than that of the overweight/obese group. Although this may at first seem somewhat counterintuitive, a study by Morin et al (1999) also reported that lactating and non-lactating heavier women consumed fewer calories in early postpartum.   This finding suggest that subjects may have been underreporting, or those who were heavier were trying to limit their intakes.  The former explanation may not be likely as it is acknowledged that accurate collection of dietary data is difficult to achieve as both intentional under- and over-reporting in food consumption are common in women, regardless of BMI classification (Laura et al, 2004).

In the present study, the only significant change in kilocalories for the whole sample was a decreased of approximately 200 kcal from 1.5 to 3 months. Gennaro and Fehder (2000) also reported a steady reduction in energy from delivery and 1, 2, and 4 months.    Thus, intakes appear to have stabilized by six months postpartum, and perhaps indicate a period after childbirth in which dietary behaviors normalize.   Other studies in predominately Caucasian mixed-income women have shown no reduction in energy from 3 to 6 months postpartum (Mackey et al, 1998), or a minimal, non significant change in kcals (Olson et al, 2003) or food intake (Hinton and Olson, 2001) between the first and second half of the first postpartum year.

We did not find any association between BMI status and fat intake. In comparison, Morin et al. (1999) found that overweight women consumed the greatest percentage of energy as fat at 24 hours and 4 months postpartum as compared to underweight, normal weight, and obese women. These conflicting reports suggest that the link between dietary fat and obesity may be weak, as suggested in a review by Willett and Liebel (2002). Despite this discord, at any given time point an average of 43% of our subjects consumed fat intakes greater than the upper limit of the AMDR (≥ 35% total energy). In a similar population of low-income African American (60%) and Caucasian women, Gennaro et al. (1997) reported 60% had high-fat intakes (>30%) at 4 months postpartum. Recalculating our data with >30% considered high fat, we found that nearly three-fourths had intakes at this level. This finding is of concern as high fat diets may be linked to an increased risk for the development of breast cancer (Bingham et al, 2003).

Between ethnicities, we found higher levels of % fat in the diets of African Americans as compared to other ethnicities in middle postpartum. In postpartum (Boardly et al. 1995) and non postpartum (Sanchez-Johnson et al. 2004), low income women African Americans consumed more kilocalories and % fat than white women and Hispanics, respectively. Also, we found higher BMIs and dietary energy values in Hispanics as compared to Caucasians at one year postpartum. This is not surprising as

Hispanic women have been reported to exhibit greater incidence of obesity and overweight than age-matched Caucasians (Freid et al. 2003).

The most provocative finding was the higher intake of calcium and vitamin D in normal versus overweight/obese women. This relationship existed despite similar energy consumption for both low and high BMI groups. However, after controlling for lactation status, calcium and vitamin D intakes were still higher in normal weight women but the significance remained only for vitamin D. It is unclear what role vitamin D may play in weight status, save this nutrient's role in calcium absorption.

A series of investigations have noted anti-obesity effects of calcium in association with dairy sources (Buchowski et al. 2002, Carruth and Skinner 2001, Lin et al. 2000), and a combination of dietary and supplement intakes (Zemel et al. 2004). The hypothesis is that calcium and dairy foods stimulate lipolysis, and decrease lipogenesis and body fat stores (Zemel et al. 2004). Epidemiological studies supporting this theory include those that used data from the U.S. National Health and Nutrition Examination Survey (Zemel et al. 2004), the CARDIA study of insulin resistance syndrome in young adults (Pereira et al. 2002), and the Quebec Family Study from Canada (Jacqmain et al, 2003). In adult populations, for example, Buchowski and colleagues (2002) reported lower calcium intakes were linked to greater BMIs in a sample of lactose intolerant and tolerant African American women. In an energy-restricted randomized, placebo-controlled trial of 32 obese men and women, Zemel et al. (2004) found that individuals who took a supplement (800 mg calcium/d) or a high calcium diet (1200 – 1300 mg/d) plus placebo experienced greater weight loss than a those on a standard diet consisting of 400 – 500 mg/d. And finally, Lin and associates (2000) reported elevated calcium intakes associated with less weight gain in a 2-year intervention study in young women.

Yet not all studies agree with anti-obesity impact of calcium hypothesis. Recently, Shapses et al. (2004) reported no significant differences in weight or body fat in 174 primarily Caucasian women undergoing a 6-month weight loss program, with and without 1000 mg calcium. They did go so far as to note that there was a small difference (1kg of fat loss), but there was no statistical relevance. Another 4 year longitudinal study of body composition in adolescents found no evidence that dairy foods were related to % body fat or BMI z-score (Phillips et al. 2003). The effects of ethnicity, age, obesity and source of calcium all appear to be confounding factors in the interpretation of data related to weight loss and calcium.

In terms of nutrient adequacy, the majority of our population was below the EAR for folate, calcium, magnesium, and vitamins $B_6$, C, D and E at every measurement during postpartum. Other studies of vitamin and mineral adequacy during postpartum have included only lactating women (Doran and Evers 1997, Berg et al. 2001, Bodnar et al. 2002, Mackey et al. 1998). For example, in a sample of 52 lactating women living in a university community, Mackey et al. (2002) found that intakes of vitamin D, vitamin E, and zinc were below Recommended Dietary Allowances (RDAs) at 3 and 6 months postpartum, and calcium, folate and vitamin $B_6$ at 6 months. In 183 Canadian lactating women, Doran and Evers (1997) reported dietary values of calcium, folate, iron, vitamin $B_1$, vitamin A, and zinc below the RDAs at 3 months postpartum. These studies, however, did not compare intakes to the EARs, so it is likely that the study population was less likely to be deficient. A recent study of premenopausal U.S. women compared intakes from the Third National Health Examination Survey to the EARs and AIs and found diets to be generally lacking in calcium, folate and vitamin E (Arab et al. 2003). These findings corroborate our results, and thus indicate a potential direction for dietary intervention strategies.

One other interesting trend in our data was that, for the most part, African Americans had adequate intakes of vitamin C when compared to Caucasians and Hispanics, and were consistently in excess of those of Caucasians. Other studies have found a similar pattern between these two ethnic groups (Champagne et al. 2004, Arab et al. 2003). Despite this finding, more African American women die of breast and colon cancer than all other ethnic groups in the U.S.

## CONCLUSIONS

Findings from this study emphasize the nutritional inadequacies of low-income, minority women during the first year postpartum. The stressors of child rearing combined with a lack of financial resources can make it particularly difficult for women to eat a healthy, balanced diet. Often times, meals that are high in carbohydrates and fat are selected because they are easy to obtain, satisfying, and usually inexpensive. However, these dietary habits that are learned in the postpartum period will ultimately lead to a much greater risk for poor health status, and even premature death. Perhaps our culture is to blame, which puts energy-dense, nutrient-poor foods within fingers reach and encourages a sedentary lifestyle. Whatever the culprits are, we must do more to ensure that every effort be made to support this segment of the population in choosing a healthful diet and putting programs in place that make better food choices more available and affordable. The inadequacy of vitamins and minerals in the diets of these postpartum women suggest that vigorous attention be given to increasing the intakes of dairy products, fruits, vegetables, and whole grains.

## Chapter 5: Conclusions and Recommendations

These results indicate that nutrition knowledge and attitudes are related to postpartum weight retention during the first postpartum year in this sample of low-income, minority women. Women who retained less weight at 1 year after childbirth had more nutrition knowledge and perceived less barriers to healthy eating that those with greater weight retention. Also, the dietary adequacy of this population was sub-optimal, as many vitamins and minerals were consumed in amounts below recommendations. Furthermore, the percentage of total energy from carbohydrates, rather than total energy or fat, appeared to be a key dietary factor that differed between normal weight and overweight/obese women. Specifically, normal weight women obtained less energy from carbohydrates and more from protein.

In the first aim of this study, the influence of nutrition attitudes and motivators for eating on weight retention at one year postpartum was explored. Nutrition attitudes and motivators for eating were assessed at 1.5, 6, and 12 months postpartum. Subjects were grouped according to body mass index. Barriers to healthy eating, such as cost and lack of time, increased for the entire sample from 1.5 to 12 months. Apparently, these new mothers found it increasingly difficult to adhere to a healthful diet as time progressed from early to late postpartum. This is not surprising because women often return to their jobs or find new work shortly after giving birth. Child rearing also becomes more complex as infants grow and become more active. An additional stressor was the burden of older children, as well as the care of other children of friends and/or family.

Obese individuals were more likely to be emotional eaters; i.e., motivated to eat in response to emotional cues, such as stress, anger, and sadness. This finding is of concern as many individuals have a tendency to overeat during such emotional states (de Lauzon et al. 2004). Therefore, education classes in public health and WIC clinics should focus on teaching effective strategies to cope with emotional stressors.

Subjects with healthful BMIs more often reported eating in response to hunger and taste. Health care professionals should emphasize strategies which minimize hunger, such as eating more frequent and smaller meals, and drinking water with each meal. Therefore, the early detection of women who eat in response to emotional cues could be part of an effective intervention used by health care professionals to mitigate weight retention during postpartum.

The second aim of this research was to measure the degree of nutrition knowledge in low-socioeconomic status women in early and late postpartum and to ascertain its influence on weight retention at 1 year postpartum. An instrument for measuring nutrition knowledge and sources of nutrition information was developed and validated in a sample of 151 women at 1 day post-delivery. The final version consisted of 25 multiple choice and true/false items. This instrument was administered to a study sample of 140 women 0-1 days and 12 months postpartum. Weight in kilograms (kg) at 12 month postpartum was compared to prepregnancy weight in terms of those who retained < 5% prepregnancy weight or ≥ 5% prepregnancy weight. Subjects with < 5% weight retention (n = 203) had greater knowledge at 0 and 12 months than those with ≥ 5% (n = 88), controlling for confounders. This finding suggests that improving nutrition knowledge could have a positive influence on postpartum weight status. Alternatively, assessment of nutrition knowledge in early postpartum may help health care personnel identify clients who are at-risk for greater weight retention and permit appropriate interventions.

The present study suggests that new mothers did not receive effective nutritional advice during the first postpartum year. Overall knowledge for the entire sample did not improve from early to late postpartum, despite that women were visiting WIC doctor's offices. However, the fact that knowledge scores did not increase is not surprising as the focus in public health clinics is on the child in postpartum, not the mother. Another alternative explanation is that the knowledge instrument used for this study may not have captured the type of nutrition information that was learned.

Knowledge scores were higher among those who obtained nutritional information from the Internet, books, and magazines, rather than a doctor's office or a dietitian. This suggests that subjects had to seek out and obtain information actively, rather than learn it passively. Alternatively, these women may have been a highly motivated subgroup of the sample, and were more proactive in their personal health care than others. One potential strategy to enhance knowledge among this segment of the population would be to encourage the use of the Internet and printed materials by increasing its accessibility, as in libraries.

The third aim of this research was to assess the levels and adequacy of nutrient intakes of low-income and minority women and identify any associations to weight status at 1 year postpartum. Participants visited a research site at 1.5, 3, 6, and 12 months postpartum. Nutrient intakes at each time point were compared to weight status at 1 year.

Results from this study indicate that the diets of these postpartum women were lacking in magnesium, folate, and vitamins $B_6$, E, and C at all time points, regardless of ethnicity, BMI and lactation status. Lactating women had higher intakes of calcium, pantothenic acid, vitamin D, and magnesium. However, non-lactating women more frequently met the EARs for phosphorus and iron. Approximately half the sample received > 35% of total energy from fat sources. Although total energy intakes did not differ between BMI groups, obese women consumed a greater percentage of total energy from carbohydrate sources. In addition, women of healthy weights had higher intakes of calcium and vitamin D than did overweight/obese women. One major difference between ethnic groups was that Hispanics had higher total energy intakes than non-Hispanic whites, and this was reflected in greater weights.

One limitation of this research is that prepregnancy weights were self-reported. Although it would have been ideal to use precisely measured body weights, self-reported weights have been used successfully in previous investigations of pregnant and postpartum populations (Kac et al. 2004, Linne et al. 2003, Lederman et al. 2002). Furthermore, studies of other adult populations have shown self-reported weights to be fairly reliable when compared to actual weights (Gunderson et al. 2001, Stewart et al. 1987). Another weakness of this research was the reliance on the accuracy of the food records. This method has inherent liabilities in the collection of dietary data, such as reporting bias, difficulty in estimating portion sizes, and unfamiliarity with certain foods. For example, studies have shown that the magnitude of underreporting of energy intakes is positively related to BMI (Heerstrass et al. 1998, Johanssen et al. 2001), and a poor body image among women, in particular (Novotny et al. 2003). Furthermore, the accuracy of nutrient intake measurements is limited to the quality of the dietary analysis software, which sometimes has missing data for some nutrients for a specific food item, or lacks the item in the database. However, most nutrition researchers are aware of the difficulties associated with obtaining precise nutrient intakes in human subjects. Therefore, the use of nutrient analysis software, such as the one used for this research, is regarded as an adequate assessment. Finally, the participants of this research may not be representative of all low-income, minority new mothers, as their active participation for the duration of the study suggests a strong commitment and responsibility.

The present study indicates that enhancement of nutrition attitudes and knowledge, reduction of barriers to healthy eating, and emphasis on diets adequate in calcium, vitamin D, and lower carbohydrate intake could minimize postpartum weight retention. Implementation of these changes by health professionals may help to diminish the high rates of obesity in low-income, minority women.

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